



**CALIFORNIA STATE SCIENCE FAIR  
2004 PROJECT SUMMARY**

<b>Name(s)</b> <b>Elizabeth L. Llanes</b>	<b>Project Number</b> <b>S0711</b>
<b>Project Title</b> <b>A Random Walk Down Chaos Street II</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> This project compares the measurements of bifurcations and chaos from an actual circuit to a 5Spice simulation of the circuit. It was hypothesized that the 5Spice circuit simulator model versus the measured points of bifurcation and chaos of an electrical circuit would differ by no more than 5%.</p> <p><b>Methods/Materials</b> To conduct the experiment, a resistor, an inductor, and a diode were connected in series on a breadboard. An oscilloscope was connected across the inductor and diode to monitor the output of the circuit. The peak-to-peak voltage of the first and second bifurcations, as well as the onset of chaos, were recorded. Applying the measured voltage value of the first and second bifurcations, Equation 20 in the research report was used to make a prediction for the onset of chaos. Then the circuit was modeled using the 5Spice simulator, and an analysis was executed to find the points of bifurcation and chaos. Three different types of diodes were used in the actual circuit and the simulation.</p> <p><b>Results</b> The results of the experiment for the actual electrical circuit were that the onset of chaos was measurable for the 1N4004 and 1N4005 diodes, and when compared against the predicted value for the onset of chaos, the error was small. The 1N4001 diode only produced a first bifurcation, but not the second bifurcation or the point of chaos. In the 5Spice simulation, the 1N4001 and 1N4004 diodes produced identical results because both diodes are modeled identically in the simulation. The 1N4005 diode had different results than the other two diodes. When comparing the actual circuit results to the 5Spice simulation results, the points of bifurcation and chaos differed anywhere from 8% to 75%. This error indicates a substantial difference between measured and simulated values.</p> <p><b>Conclusions/Discussion</b> In conclusion, the data recorded does not support the hypothesis that the actual circuit and the 5Spice simulation measurements would differ by 5% or less. In fact, the difference between the two were quite substantial.</p>	
<b>Summary Statement</b> This project compares the measurements of bifurcations and chaos from an actual circuit to a 5Spice simulation of the circuit.	
<b>Help Received</b> Mr. Wellman helped with research materials. Teradyne Inc. allowed me to use their oscilloscope. My father taught me basic calculus.	