



**CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY**

Name(s) David R. Lester	Project Number J1912
Project Title Synthesis of Piano Notes	
Objectives/Goals I was curious about the sound of piano and wondered if it was possible to create notes that sounded as realistic as the piano notes and better than my electronic keyboard. Since a keyboard uses electronics rather than strings to generate sound, I wondered how close the electronic keyboard actually comes to correctly reproducing the sound of piano notes. By studying the properties of piano sounds and reproducing these sounds using MATLAB, the notes of the piano can be synthesized with greater precision than is achieved by an electronic keyboard.	
Abstract I learned how to program in MATLAB, a mathematical/engineering program. Using MATLAB I created a fundamental frequency to mimic a "c" note. I recorded the sound of seven "c" notes on the computer and found that each note not only has harmonics but also inharmonics. I duplicated the harmonics and inharmonics of the piano using MATLAB. I also recorded the electronic keyboard notes and found that my synthesized notes sounded more like a piano than the keyboard. Materials- Samick upright piano/ Yamaha Midi keyboard/ Microsoft Sound Recorder/ MATLAB computer program/ Cyber Acoustics microphone/ Dell laptop computer.	
Methods/Materials I learned how to program in MATLAB, a mathematical/engineering program. Using MATLAB I created a fundamental frequency to mimic a "c" note. I recorded the sound of seven "c" notes on the computer and found that each note not only has harmonics but also inharmonics. I duplicated the harmonics and inharmonics of the piano using MATLAB. I also recorded the electronic keyboard notes and found that my synthesized notes sounded more like a piano than the keyboard. Materials- Samick upright piano/ Yamaha Midi keyboard/ Microsoft Sound Recorder/ MATLAB computer program/ Cyber Acoustics microphone/ Dell laptop computer.	
Results After matching up the fundamental frequency, harmonics, and inharmonics, I found that my note sounded more like a piano than the keyboard. I learned that the sound of piano notes decays exponentially. Once all these terms (harmonics and inharmonics) were programmed, it was hard to tell the difference between the actual piano note and the synthesized note. The results showed that as the notes increased in frequency, less harmonics were evidenced both in the piano spectrum and the keyboard spectrum. As the frequency increased, the recorded piano notes showed a shorter time duration, whereas the keyboard notes showed a nearly constant duration. The keyboard notes sound more artificial at the higher frequencies than at the lower frequencies. My synthesized notes sound more like a piano than the keyboard.	
Conclusions/Discussion My hypothesis stated that the notes of a piano can be synthesized with greater precision than that produced by an electronic keyboard. After doing my project and spending time analyzing the results, I came to the conclusion that it is possible to create your own synthesized notes which sound better than the notes of a keyboard.	
Summary Statement Using MATLAB, a mathematical/engineering program, I was able to generate a fuller sounding piano note than one produced by an electronic keyboard.	
Help Received Grandfather and uncle helped understand MATLAB and helped record notes; Mother helped type report	