



**CALIFORNIA STATE SCIENCE FAIR  
2016 PROJECT SUMMARY**

<b>Name(s)</b> <b>Robert C. Henning</b>	<b>Project Number</b>  36297
<b>Project Title</b> <b>The Exchange Improving Unit: An Auditory Device for Directional Filtering: A Second-Year Study</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Hearing aids have a fundamental limitation - when used in areas of high ambient noise such as restaurants or public buildings, they amplify background noise as much as desired sounds. This can lead to the user struggling to separate the voices they are listening to from other sounds. The goal of this project was to develop and build a device that would allow hearing aid users to select the directions that they hear from, enabling them to filter out undesirable sounds. <b>Methods/Materials</b> The approach taken was through using an array of four microphones to analyze from which direction each sound harmonic originated, and removing the sound components that fell outside of defined parameters. The processing was performed on an FPGA, with an external Atmega32u4 sending parameters set by a user interface. <b>Results</b> The device is able to effectively determine the directions of origin of sound sources and can filter out noise from all directions. <b>Conclusions/Discussion</b> The limitations of dynamic potential currently limit the quality of sound for music, but the inclusion of CIC filters and even Wavelet Transforms could make the system further optimized. This system is more ideal than shotgun-microphones and similar aids in that this device works with multiple sound sources, for a group setting, and only needs to be setup once with new configurations of speakers. A prototype, with an accurate user interface, is functioning at filtering sounds from undesirable directions.	
<b>Summary Statement</b> This project involved producing and testing a handheld device to actively remove ambient noise for hearing aid users using an array of microphone arrays and advanced digital signal processing on a custom circuit board.	
<b>Help Received</b> This project was done as part of the Clark Scholars program, where participants have access to the facilities at TTU. I brought this project after my first year of work at home to complete it, independently, in the lab of and under the mentorship of my program advisor.	