# Acoustical Analysis of Longitudinal Waveforms In Relation to Suitability of Non-Designated Areas for Musical Quality Sound Containment

AiS Challenge
Final Report
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Team #73
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We intend to submit this project for the competitive track.

# Executive Summary

Santa Fe High School has begun to grow too large for many of its current buildings. The band room especially is not large enough to house the number of students interested in participating.

In order to help eleviate this problem, we set out to develop a computer program which acoustically models the characteristics of a room, and more specifically, enables us to determine if certain existing rooms at Santa Fe High are suitable for use as band rooms.

Our program takes a room of a given size (10’ x 10’ to start with) and establishes a point from which sound waves are emitted. The program then tracks the waves as they reflect off of surfaces in the room and consequently interact and interfere with each other.

We have found that modeling the basic properties of acoustics is not terribly difficult, and can be used in certain settings to gain a general idea of the acoustical qualities of a room. We also learned that there are many

steps that can be taken to add complexity to such a program in order to create a more realistic situation.

## Problem Definition

The students at Santa Fe High School have great pride in their school, and this year especially have joined together to support their many sports teams.  Many students have chosen to show their support by joining the marching band, which this year improved significantly and was invited to play at both the pre-game ceremony and halftime at the Cotton Bowl in Dallas, Texas.  Unfortunately, with so much new interest in the band program, the current band room is not large enough for the demand put upon it.  The school, therefore, needs to find another room to use for band practice.  With this problem in mind, our team undertook the task of acoustically modeling one of the large art rooms above the band room to determine if it would be suitable for use as such a musical environment.

## Procedure and Results

When first defining our project, we thought to concentrate solely on the phenomenon of destructive wave interference

of sound waves traveling through water or air, completely disregarding the other aspects of acoustics (like wave reflection). However, as we progressed in defining the problem, we realized that trying to confine it to such a limited sphere would not only create an extremely unrealistic situation, but would also be difficult to model. Accordingly, we revised our direction slightly to focus on the way sound waves emitted from a point-source will reflect off of room surfaces and how the resultant waves with interact with each other. A few significant factors in how and when they interact are the speed of the wave, wavelength, frequency, and the angle that the waves reflect off of walls and other surfaces.

Our team has produced a two-dimensional model of a room, 10 meters by 10 meters, in which sound waves, represented by particles on the wave front, are emitted from a point at varying angles. We track their positions at certain time-steps (e.g. every .001 seconds) in order to first study how they reflect off the various walls in the room. We know that sound travels at 376 meters per second at room temperature (70 degrees F). From this we have been able to determine how far the wave travels in a certain time interval, and we can also determine the angle of reflection

(and therefore the positions) of several sound waves traveling in the same room. We have also witnessed points at which two or more waves interfere with each other, thus, causing them to cancel each other out. In our model, we have assumed the walls and ceiling of the room do not absorb any of the sound, and we have disregarded all obstacles in the room.

We originally hoped to be able to have a computer model of the way sound travels around a typical room containing obstacles and other characteristics. Due to a lack of time and resources, we have yet to add all of the complexity, but we do plan to eventually achieve that level of complexity.

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