Classroom Acoustics

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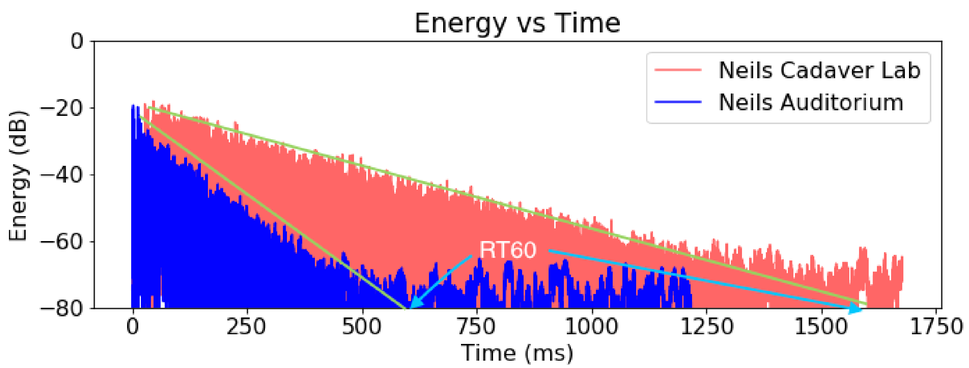
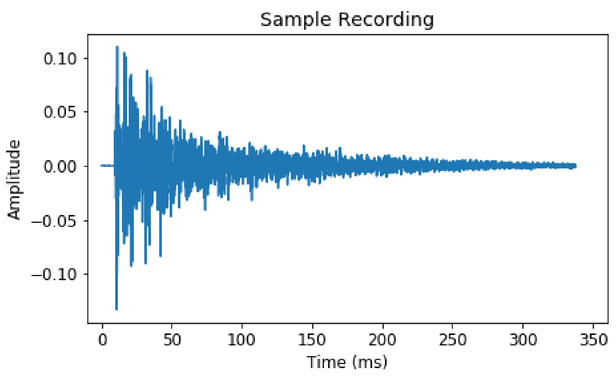
How can they believe in the one of whom they have not heard? And how can they hear [with poor classroom acoustics] Romans 10:14b (modified)

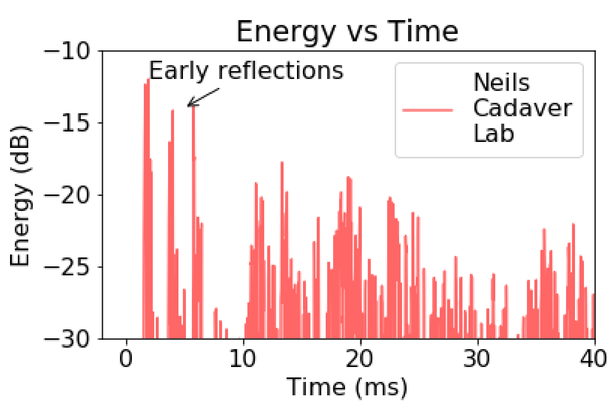
In April of 2017 acoustical testing was done in the Gellersen Center room 159 (GEM 159) to analyze the intelligibility of speech in the classroom. The room has since been renovated with new furniture, new ceiling tiles, and drywall put over the brick walls. We repeated the same tests in the room to see if the renovations had improved the acoustics.

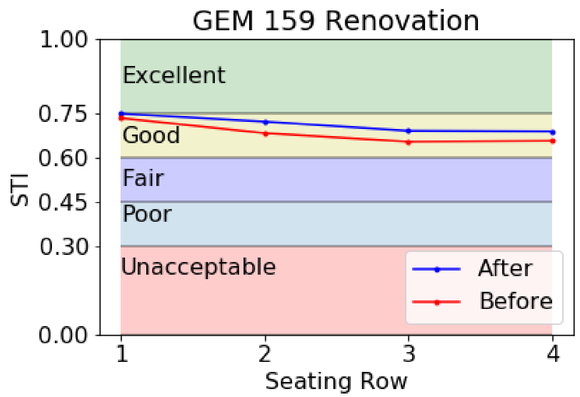
To acquire some comparisons of rooms known to be good and bad, we ran the same tests in the Auditorium in Neils, which was believed to have a very nice acoustic and the new Cadaver lab in Neils, a room in which trying to listen to someone talk requires more concentration then an average student might be willing to give – a clearly bad acoustic. These rooms allowed us to verify that our analysis for GEM 159 was reasonable.

The tests were done by popping balloons at various locations around the room to create a single, high energy, impulse wave. This, and the resulting echoes, were recorded by calibrated microphones placed in different rows throughout the classroom. Below is a sample of the unprocessed sound recording.





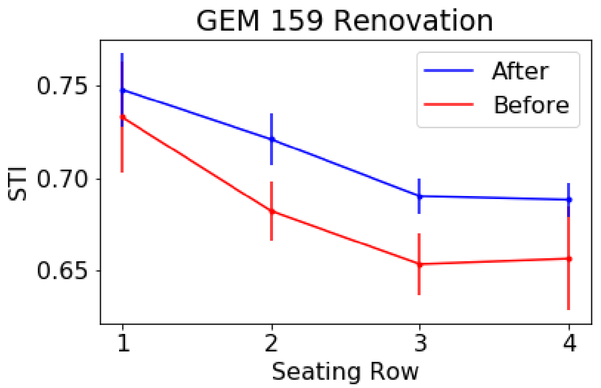




The main parameter we looked into was the Speech Transmission Index (STI), a value from 0 to 1 that characterizes the quality of speech transmission in the room. With 0 being completely unintelligible and 1 being perfection. The biggest problem we encountered here was there existed no free software to calculate STI. So we did what had to be done and created the program ourselves. Once we had the code working we were able to quickly get STI's from every recording. We then averaged all the recordings to get a general overall STI for each room.

The ranges above are the standard set used for acoustical analysis. Each of the data points is 24 recordings averaged together. You can see how much the data varied below. According to our results GEM 159 has improved slightly and is within the standard good range. However, if either the speaker or the listener's first language is not English, common in collage classrooms, then good just isn't good enough. Why settle for good when you can be excellent?

	Average STI
Cadaver Lab	0.55
old-159	0.69
new-159	0.72
Neils Auditorium	0.75



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Above are two samples, taken from the Auditorium and Cadaver Lab, of the total energy in the room plotted against time. From this you can get a few common parameters: Reverberation Time(RT), and Early Decay Time. Reverberation Time is a measure of how long it takes for the energy to drop by a set amount, commonly 60 dB (RT60) or 30 dB (RT30).
Early Decay Time is the time between the direct sound and the first reflection.

Where does this leave us? For starters we plan on making our code for calculating STI fully available to the public, allowing everyone easy access to something that could be used to show that a room has problems and needs to be changed. Future studies based on this could be done to see how a room affects one's ability to learn. The availability of this software may make it easier to make all rooms excellent.

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