Hearing Damage to Go

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Abstract

Since the Science Learning Center (SLC) has opened, several students have complained about the noise generated by the Xlerator hand dryers. Upon testing, noise levels were recorded as high as 103.7 decibels inside the restroom, and 69.1 decibels outside the restroom with a closed door. In comparison with the Student Services Building (SSB) on campus, the problem appears to be that there is more reverberation in the Several recommendations for mediating some of the reverberation and monitoring are recommended, including tile removal from the long walls, moving the dryer away from so many corners to reduce reverberation, and moving lighting and sealing the large recessed chamber.

Introduction

It never fails that while I am in the Science Learning Center (SLC) restrooms that someone activates the hand dryer and noise hurts my ears. In speaking with other students and instructors, I am not alone in my complaint.

The National Institute for Occupational Safety and Health (2011) charts hearing damage can occur at 85 decibels (dBA) over an eight hour exposure. Allowable exposure time decreases as decibels rise. Anything at or above 85 dBA is required to be monitored as per the Occupational Safety & Health Administration's standard 1910.95 App G (2013). Initial research into why the SLC restrooms seem so loud puts blame not so much on the hand dryer, but on how it is used (i.e. palms up instead of down) and the placement near so many corners by the sink instead of along a straight wall (Hansen, Goelzer, 2001). To test the idea that moving the dryer location would decrease the noise level, I compared the noise level with identical hand dryers in another building. The hand dryers in the Student Services Building (SSB) are along a straight wall, and the hand dryers in the SLC are located next to sinks. Most other restrooms on campus either use a different type of hand dryer or still use paper towels. The purpose of this comparison may also serve as a basis for relocating the hand dryers in the SLC and reduce everyone's exposure to excessive noise that may, over time, cause hearing damage. Mt hypothesis is if the hand dryers in the SLC restrooms were moved to the straight wall away from all of the corners at the current positions, the restroom would not be so loud and not hurt my ears.

EXPERIMENTAL DESIGN

In order to minimize variables, the hand dryers were tested in empty restrooms on three floors in the SLC building. For a comparison, two restrooms in the SSB were tested. Reasons for only testing two of the four restrooms in the SSB will be discussed in the Problems section. The same type of hand dryers are used in those restrooms. I was unable to obtain model numbers for the dryers.

In order to get a better idea of how much students are exposed to the sound levels generated by the hand dryers, I took sound readings at two locations in each restroom and one outside at a standard distance from the closed door of the restroom. In order to simulate conditions where the decibel meters would "hear" at the same height as the average female student at UT Dallas. The average height of the average female UTD student can be determined by starting with the average age. Because height changes over as we age, age is pertinent to determining the average height. The average age of students on campus in 2003, the most recent value was 24.4 years for undergraduates and 29.7 years for students in the master's program (OSPA, 2013). The average height of females in the United States was found using the US Census report. For females between the ages of 20 and 29 the mean height is 64.3 inches, or 163.322 cm (McDowell, Fryar, Ogden, Flegal, 2008). The next measurement needed was the placement of the ear canal on the head. Unfortunately, the only reference found gave measurements for males, but not females. Head height is determined by measuring the linear distance of the top of the head to the center of the ear canal on the transverse plane. For males this height is 215 mm, or 8.46 inches (Maroonoge, Emanuel, Letowski, 2013). Because a key piece of information as missing, I had to improvise. Head length averages from the same reference for both males and females were found. Head length is measured on the coronal plane from the point where the frontal bone meets the nasal bone to the occipital protuberance (Maroonroge, 2013). The head length for males is 196 mm and 180 mm for females. Using these numbers as a ratio, acquire head height for females was determined. The head height was reduced by 8.2 percent and a head height of 197 mm, or 7.75 inches, was used for the experiment. Armed with this information, the necessary equipment to create a way to record sound levels was gathered.

Materials List

To create a standard measuring device, sound meters would be needed to be taped to meter sticks to simulate the height of our average UTD female student. The UTeach center has data loggers and access to a professional sound meter, both with software for recording tests. The data logger recorded humidity, temperature, light, air pressure, and sound, while the Phonic recorded sound and frequency.

Phonic 1200 Personal Audio Assistant Sound Monitor
Phonic 1200 Personal Audio Assistant Software
Data Harvest Easy Sense Q5 Data Logger
Data Harvest Easy Sense Q5 Software
Four meter sticks
Masking Tape
Computer
Tape Measure
Pen and Notepad

To record the sound levels at “ear height” masking tape was used to tape together two meter sticks together in two spots. The top meter stick was marked at the height of 163.3 cm (average height of female UTD student) and at 143.6 cm (average height of ear canal). Each monitor was attached to a two meter stick setup such that the microphones of each monitor were at 143.6 cm (see Figure 1, below).

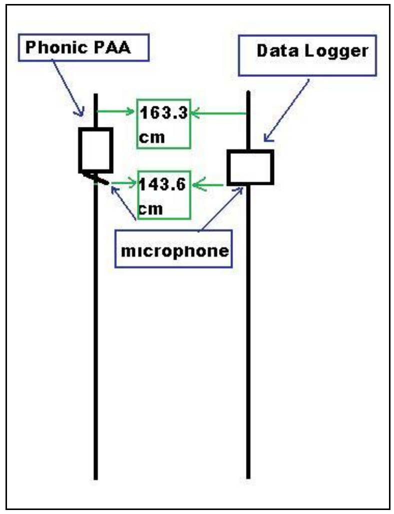

Figure 1 - Meter stick setup with sound monitor microphones aligned to the ear canal height of 143.6 cm.

Sound level readings were taken at three positions. The first position for readings was to be at twelve inches (30.48 cm) in front of the hand dryer to simulate a person drying their hands. The second position was at the farthest corner (distance varied) of the room to see how different the noise level was. The third position was outside in the hallway 100.5 inches (255.27 cm) from the closed door of the restroom and taped against the wall to see how loud the dryer was out in the hallway.

Because I had noticed the different ways that women dry their hands over the last two years, I ran trials at each position: palms up and palms down. The first trial was to simply run my hand beneath the dryer nozzle to activate it and then allow it to cutoff. The second trial was to activate the dryer and rub hands together with palms down for five to ten seconds, remove hands, and allow dryer to cutoff. The third and last trial was to activate the dryer and rub hands together with palms up and cupped for five to ten seconds, remove hands, and allow dryer to cutoff. This procedure was followed for each position in each restroom tested.

To prepare for each run, I entered the restroom, measured and taped the sound monitor setups to the wall, then setup the computer to record each monitor. With computer programs on split screen, I was able to monitor while running trials. After each trial was completed, files were saved for further analysis.

One of the safety concerns for this investigation was to be careful to wipe off the counter for the computer to avoid any electrical issues caused by contact with water. Care was also taken with the monitor setups so that they did not get wet or fall and damage the meters or hit me. Ear plugs were worn to limit my own exposure to the noise testing.

ANALYSIS

The readings that were recorded during testing surprised me. Samples of readings from the second floor of the SSB and for the first floor of the SLC had the following graphs of recorded values for activations of the dryer (see Figure 2 and Figure 3, below). In Figure 2 from the SSB, the hand dryer was activated at 140 seconds, and allowed to cut off at 160 seconds with a maximum noise level of 88.6 dBA. The second activation began at 241 seconds. Hands were dried under the spout with palms down. The dryer was cut off 301 seconds at a maximum noise level of 100.4 dBA. The third trial was started at 441 seconds. Hands were dried in the palms up and cupped position. The dryer cut off at 501 seconds with a maximum noise level of 103.1 dBA.

In Figure 3 from the SLC, the hand dryer was activated at 109 seconds, and allowed to cut off at 136 seconds with a maximum noise level of 92.8 dBA. The second activation began at 217 seconds. Hands were dried under the spout with palms down. The dryer was cut off 298 seconds at a maximum noise level of 101.6 dBA. The third trial was started at 406 seconds. Hands were dried in the palms up and cupped position. The dryer cut off at 487 seconds with a maximum noise level of 103.7 dBA. Additional comparative graphs can be found in the Appendix.

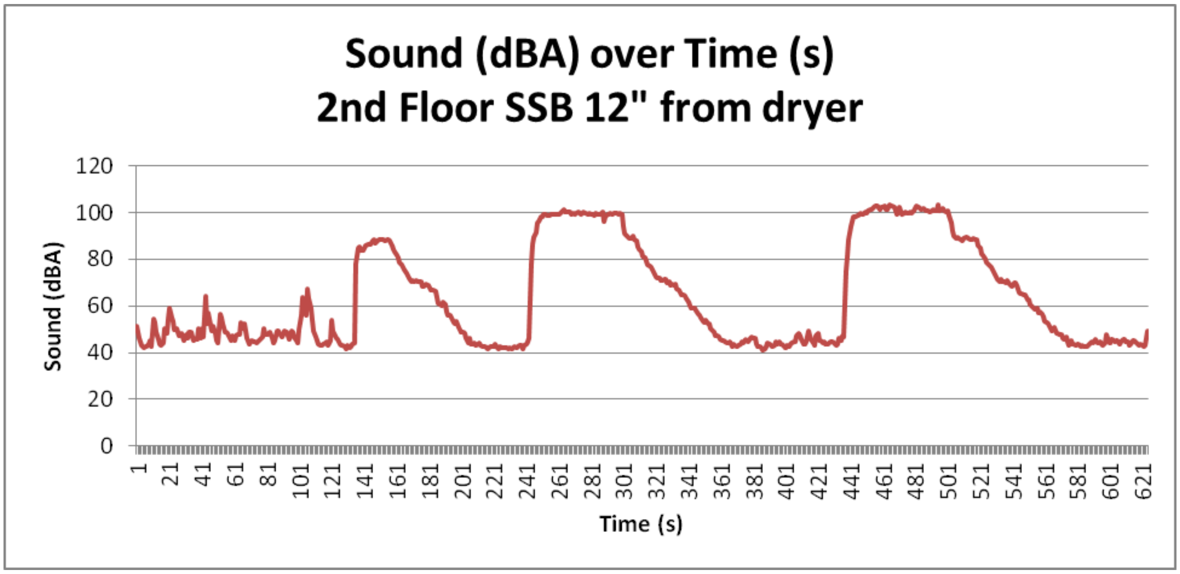

Figure 2: Hand dryer activated and left to run, activated and hands palms down, and then activated and hands cupped, palms up. (max 103.2 dBA)

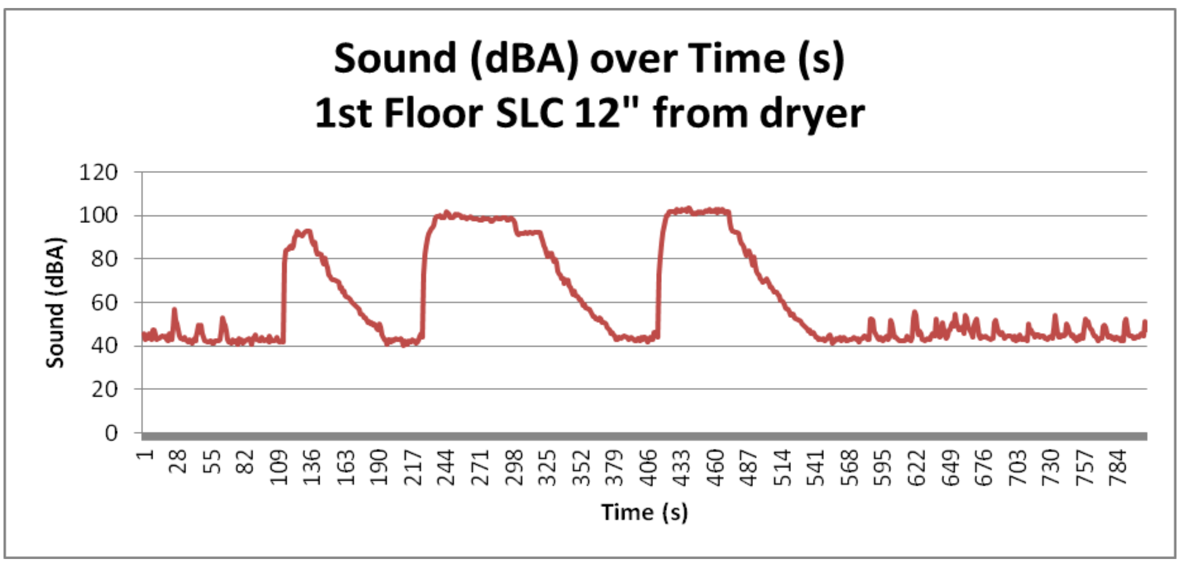

Figure 3: Hand dryer activated and left to run, activated and hands palms down, and then activated and hands cupped, palms up. (max 103.7 dBA)

At each activation of the hand dryer in both buildings, SSB and SLC, the hand dryers emitted well over 80 decibels, without anyone's hands under the dryer spout. There were higher noise levels when hands were placed under the dryer spout, with the greatest decibels being reached when hands were palms up and cupped. Although I had thought that the two buildings would yield drastically different results, this was not the case. The two trials had very similar results with maximum noise levels above 103 dBA. However, the sound took longer to die off after the dryer cutoff in the SLC restroom. In the SSB, the dryer took seven to ten seconds to return to base levels, increasing as the noise level rose. In the SLC, the dryer took roughly six seconds to return to base levels for each trial. This may be due to the number of surfaces the sound has to bounce around. In the SSB restrooms, the long wall has no tile and there is no recessed lighting. The SSB restroom also has an inset plate around the hand dryer with a rounded bottom that redirects the airflow and perhaps lessens reverberation. In the SLC restrooms, all walls are tiled and there is a large gap for recessed lighting above the sinks, creating more places for the sound to reverberate (Hansen, 1996).

PROBLEMS

As with most investigations, several problems were encountered during testing.

1. The SSB only had one restroom on the second floor that was comparable to size and shape of the restroom in the SLC. The other restrooms in the SSB were smaller and only had two stalls, while the all of the three restrooms in the SLC were of consistent size and shape with four stalls. That reduced my sample considerably.
2. The battery on the computer died after only testing two restrooms in the SSB and I was unable to continue.
3. I could not hold the equipment with the monitors attached consistently straight or level while running the tests. The first position had to be changed to twelve inches (30.48 cm) to the right of the dryer and taped against the wall.

4. Difficulty was encountered when attempting to analyze data collected by the Phonic 1200 Personal Audio Assistant Sound Monitor. The information was unable to be opened so all data within this report was collected from the Data Harvest Easy Sense Q5 Data Logger.

I expected to have some unforeseen complications, however, not this many. Another investigation with repeated trials in each restroom of the SLC and SSB, as well as other buildings, would be required for this report to have any relevance.

CONCLUSION

My hypothesis is invalid. Similar sound readings were found in both restrooms. The plate around the dryer and having one long wall without tile appears to have shortened the length of time that the sound took to die off. Making similar changes to the SLC restroom may reduce the length of time of exposure to high decibels for students, faculty, and staff in this building.

Another consideration for the UTD safety staff to consider is that they may not be in compliance with OSHA. Sound monitoring should be done when there are sounds at 85 decibels and above (OSHA 2013).

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