

MUSICIANS' HEARING LOSS:
DEFINING THE PROBLEM & DESIGNING SOLUTIONS

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INTRODUCTION

Human beings are barraged by sound on a daily basis. We cannot escape sound. It is in the nature of life, in the fact that molecules move, that sound exists. Without sound, we do not breathe. Musicians have devoted their lives to sound, both to its perception and its production. How often do they consider the limitations on their perception of sound? Are musicians aware that their participation in musical activities could cause them to lose their functional hearing over time? Hearing loss should be a concern for any living person, but it is particularly important for a person who intends to make a living through music. Although everyone must be made aware of the danger of noise-induced hearing loss (NIHL), this is especially true for those who use their hearing for their livelihood.

After defining terminology, I will explain current sound safety standards and expose hazardous environments and risk factors that musicians experience regularly, including a look into Texas State University's School of Music. Much of the information shared in this thesis stems from personal research and experience with hearing loss and related issues as a musician. Topics such as the dangers of amplified music and other various lifestyle choices (such as listening to personal music players at high volume) are well established and will not be addressed within this paper. The purpose of this paper is to address the environments that are inherent in the music curriculum at Texas State University, not on environments students may choose to experience. The focus is on environments that administration and faculty of the School of Music are able to control or modify.

The remainder of the paper will address the possible solutions to help musicians (especially those in an educational setting) preserve their hearing. Ways of reducing

sound hazards and risk include environmental and acoustic modifications, use of hearing protection devices, administrative controls, and raising awareness through educational and interpersonal means. The conclusion will explore the challenges involved in resolving the problem of musicians' hearing loss and noise-induced hearing loss. It will also include goals for the future implementation of a hearing conservation program at the Texas State University School of Music.

TERMINOLOGY

Understanding the mechanism of hearing is essential to understanding hearing loss and the dangers of loud sound. The ear is made up of three major sections: the outer, middle, and inner ear.

The outer ear includes the auricle (also known as the pinna, the entire external portion of the ear) and the auditory canal. Together, these two parts serve as a receiver and funnel for



Figure 1. Ear anatomy (National Institute of Health).

physical sound waves. The tympanic membrane (eardrum) seals off the outer ear from the middle ear. The middle ear is where sound waves are amplified by the action of the ossicular chain. This is comprised of the three smallest bones in the body, the malleus, incus, and stapes (often referred to as the hammer, anvil, and stirrup because of their respective shapes). These physical vibrations are transferred into the cochlea, the main

snail-shaped part of the inner ear, where physical vibrations are transduced into nerve impulses that are sent to the brain and interpreted as sound (McCoy).

Hearing impairment can occur as either conductive or sensorineural hearing loss. Conductive hearing loss indicates a problem with the physical mechanisms of hearing. Sensorineural hearing loss indicates a problem with the electrical (nerve-related) portion of hearing. There are a variety of causes for any type of hearing loss. The focus of this paper is on a type of sensorineural hearing loss called noise-induced hearing loss (NIHL).

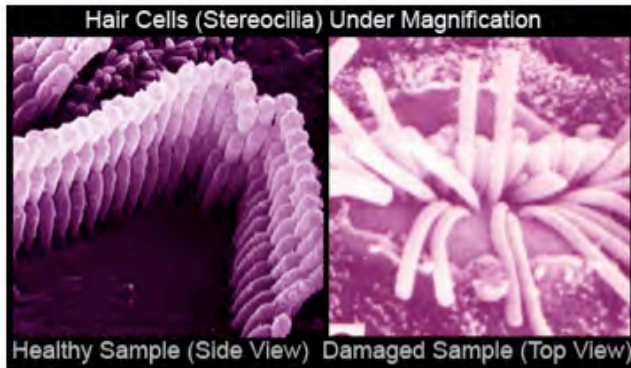


Figure 2. Hair Cells (GenerationDeaf.com).

Inside the cochlea is a balance of fluids divided by a layer of small sensory receptors called hair cells. It is through a shift in ionic charges that hair cells convert physical energy into electrical energy to be interpreted by the brain. The

problem is that hair cells are very sensitive and never regenerate. Think of hair cells as blades of grass. Walk on them a little and they can recover; walk on them too much and they die (“Hearing Loss”). When hair cells are destroyed, the associated sounds (hair cells are organized in the cochlea according to the frequency they receive) are no longer sent to the brain.

In order to understand hearing loss, a few basic terms for sound measurement must be introduced. Two of these terms are commonly known as pitch and volume. Pitch refers to the frequency of sound, measured in Hertz (Hz). This number represents

cycles per second. A cycle is completed each time a position of maximum (peak) amplitude passes, as shown at right. A higher number of Hertz indicates a higher pitch and vice versa. In terms of musical pitch, the lowest note on the musical staff is ~98 Hz, the pitch for orchestra tuning is 440 Hz (the A above middle C), and soprano high C is 1,046.5 Hz (McCoy). Healthy ears have the ability to perceive sounds from ~20

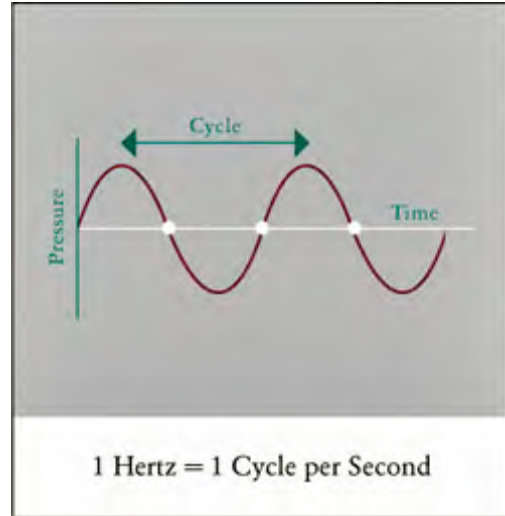


Figure 3. Hertz (esoundproof.com).

Hz to ~20,000 Hz (20 kHz) (“Occupational”). The piano’s frequencies range from 27.5 Hz to 4,186 Hz (McCoy).

Most people use the word “volume” to describe their perception of sound pressure. Volume in this sense is more akin to musical dynamics than to actual measurements. Volume, when actually measured, is known as sound pressure and is given in units of decibels (dB). Sound pressure is a measurement of wave amplitude (displacement from equilibrium). It is a measure of force (Matyear). The decibel scale is logarithmic; accordingly, an increase of about 3 dB indicates a doubling of sound pressure. A single decibel is close to the “just noticeable difference” for sound level, while a change of 3 dB is readily perceptible (Wolfe). Decibel measurements vary based on distance from the source and characteristics of the surrounding environment. With a doubling of distance, decibel measurements decrease by about 6 dB (half the sound pressure and a quarter of the intensity) in a non-reflective atmosphere (Wolfe). Many

measurements do not specify the conditions under which they were taken, which can make studies related to sound level measurement rather misleading.

The decibel is a unit of measure that is always relative to a specified reference level and it can be applied in many fields, including electronics and acoustics. Sound pressure level measurements are taken in dB SPL, while measurements of hearing loss (as seen in an audiogram) are usually recorded as decibels hearing level (dB HL), in reference to a variable minimum audibility curve (Wolfe). A closer look at the decibel reveals several key sound levels to remember. The threshold of human hearing is the average of the quietest sound that can be heard and is standardized at 0 dB, although thresholds do vary from person to person. Typical conversation (at three to five feet) is around 60 dB. The “pain threshold” is at 125 dB. The sound of a jet engine from 100 feet away puts out 130-140 dB (“Decibel Trivia”), which is why airport ground workers wear industrial hearing protection devices.

Sound Source	Sound Level
Threshold of hearing	0 dB
Whisper	30 dB
Normal conversation at 3-5 ft	60-70 dB
City traffic inside car	85 dB
1983 OSHA monitoring requirements begin	90 dB
Train whistle at 500 ft	90 dB
Pain threshold	125 dB
Jet engine at 100 ft	130-140 dB
Loudest possible sound	194 dB

Figure 4. Common Sound Levels (Adapted from “Decibel Volume,” NHCA).

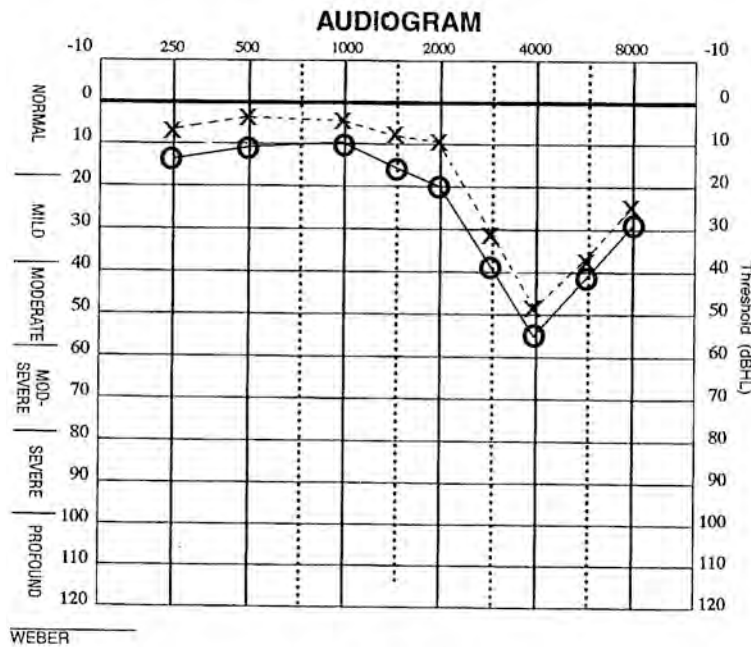


Figure 5. Typical NIHL Audiogram
(Adapted from “Audiometric Evaluation,” Weber).

as portrayed below. In a hearing test, patients will receive an audiogram with points plotted as a line graph to show individual thresholds of hearing (measured in dB) at a minimum of six important frequencies (measured in Hz) for each ear.

Finally, in this paper, the use of the word *noise* is in reference to a sound pressure level that is considered excessive by audiology standards. This usage is aligned with the Occupational Safety and Health Administration’s use of the word *noise* (i.e. noise-induced hearing loss). However, the word *noise* truly denotes a complex, aperiodic sound that includes many simultaneous frequencies without the percept of any one frequency or pitch; the word makes no specific reference to sound pressure level (Matyear). Yet the former is the intended meaning of the word *noise* unless otherwise noted.

An audiogram is a diagram that shows an individual’s thresholds at various frequencies in both ears, tested independently from one another by a certified audiologist (Au.D., CCC-A). Several degrees of hearing loss exist, described as mild, moderate, moderate-severe, severe, and profound,

In order to measure sound pressure level, acousticians frequently use one of two specific tools. The first is called a sound level meter and can be purchased inexpensively at Radio Shack or from various vendors on the Internet. Whenever it is in use, it takes active measurements of decibel levels at its location, showing every change in sound pressure level. The second and more expensive tool is called a dosimeter (or “noise badge”). Dosimeters come in several forms, but always serve the same purpose. A dosimeter is intended to measure sound as near to the ear as possible and to monitor an individual’s noise exposure over time. In America, Occupational Safety and Health Administration (OSHA) sets the standard requirement. OSHA defines a time-weighted average of 85 dB over eight hours as the border between safe and hazardous sound levels. A dosimeter gives a percentage of one’s total safe sound dose, based on a constant calculation of sound pressure and time. A reading of 100% is the maximum amount of safe sound exposure; higher measurements are frequently encountered and are indicative of hazardous sound exposure. Marching band participants have been shown to experience over 300% of their safe sound dose during a five-day band camp (“Music-related”). In comparison, a sound level meter is most appropriate for incidental measurements while overall sound safety of a particular environment is best determined with the use of a dosimeter.

Many organizations aim to regulate sound or promote awareness of noise-induced hearing loss. Government organizations include OSHA, which is part of the United States Department of Labor, and the National Institute for Occupational Safety and Health (NIOSH), a branch of the Center for Disease Control (CDC), which is part of the United States Department of Health and Human Services. Academic organizations

include the National Hearing Conservation Association (NHCA), the American Academy of Audiology (AAA), the Texas Center for Music and Medicine at the University of North Texas, and the Music Research Institute at the University of North Carolina at Greensboro. Awareness groups include Hearing Education and Awareness for Rockers (HEAR) and Dangerous Decibels. Each of these groups will be used frequently as references for various topics throughout this paper.

THE PROBLEM

NOISE-INDUCED HEARING LOSS & TINNITUS

There is a preponderance of information about the dangers of high-intensity sound to the general public and the need for moderation in order to conserve hearing. It is much more difficult to find information about the sound levels that musicians experience outside of bars, clubs, or rock concerts. Some research does demonstrate that professional musicians are regularly exposed to dangerously loud sounds (Chesky, “Preventing”). It has also been suggested that 30 to 50% of musicians report problems with hearing loss (Chesky, K., William J.). Specific research at the University of North Carolina at Greensboro found high frequency hearing loss (typically caused by acoustic overexposure) in 52% of its undergraduate music majors (“Music-Related”). These surprising statistics clearly indicate the significance of this issue for musicians.

I myself have been experiencing a unique and unusual case of hearing loss for the past several years. It began with a failed hearing screening my freshman year in high school, followed by an otolaryngologist’s (Ear, nose, and throat doctor (ENT)) diagnosis of otosclerosis, a progressive form of conductive hearing loss. The third bone in my ossicular chain, the stapes, was calcified and, therefore, not transmitting vibrations properly to my cochlea. It was causing low frequency hearing loss in both ears, typical of otosclerosis. I was missing a lot of vowel sounds and voiced consonants in speech. I unintentionally learned to read lips. Repeatedly, I struggled to hear (literally, *perceive* sound) if there was any visual obstruction or distraction. Sounds were too quiet. I lived with the knowledge and disbelief that I had this genetic disorder for five years as I

advanced through my high school's choral program. Only after some years of significant struggle did I really believe that I truly had hearing problems.

The contrast between my two ears is dramatic. My new complaint is that I can hear speech but often cannot understand it. Sounds are loud

Figure 6. Speech Banana (American Academy of Audiology).

hearing is abnormal. My audiogram now shows two ears that hear oppositely [See Appendix A].

This bizarre exchange of hearing abilities was not the only consequence of my operation. Tinnitus, a sound in one or both ears without external stimulus, reared its ugly head as well. Before surgery, I had occasionally experienced tinnitus as a ringing or pulsating in my ears. After surgery, the tinnitus was dramatically different, like the constant roaring of the sea, or the sound heard when holding a conch shell to the ear. I had a surgical revision on the same ear about ten months later, hoping to correct what went wrong the first time. The roaring in my ear then became a hissing, much like the sound of a snowy television screen. To me, this was an improvement, but otherwise, the revision did not correct my hearing as hoped. In light of my personal circumstances, I have become much more sensitive to the sounds that I experience.

In a recent study, 61% of voluntary participants in a web-based survey reported experiencing tinnitus during attendance at loud music venues (Chung). I can attest that tinnitus is horrible. It is a constant stressor. The National Hearing Conservation Association says that tinnitus is a sign of potential hearing damage. It is an indication of exposure to excessively loud sounds (“Hearing Loss”). This is an instance of “walking on the grass.” Hair cells may recover from this excessive sound exposure, but it may be the beginning of a downward spiral of hearing loss.

Another sign of damage is a temporary threshold shift (“Hearing Loss”). Essentially, this is the period of time after exposure to loud sounds during which hair cells are trying to recover. A temporary threshold shift means that sounds must temporarily be louder in order for you to perceive them at all. This is very common after

attending a loud event, such as a rock concert, but it can occur from other loud environments or incidental noises (such as gunfire) as well. In an online survey, 43% of respondents reported having had this experience after or while attending loud music venues (Chung). The trouble is that most people don't realize that any damage done is permanent and that damage may not be recognized until there is a serious problem. According to Eileen Daniel, up to 30-50% of a person's hair cells can be damaged or destroyed before any measurable sound level of hearing loss is detected. Hearing loss is an invisible but serious disability; therefore, preventative measures are necessary.

SAFETY STANDARDS

Enough people are aware of the problem of hearing loss that the government is involved in several sectors. Namely, this includes the United States Department of Labor and the Department of Health and Human Services with their organizations OSHA and NIOSH, as previously mentioned. The U.S. Environmental Protection Agency (EPA) acknowledges that musicians are at risk of sound exposures that may damage hearing among the ranks of other dangerous occupations such as firefighters, military personnel, construction workers, miners, and factory workers (Hearing Education 2004). Safety standards are regularly implemented in these other fields, but are largely ignored in the area of music.

The Hearing Education and Awareness for Rockers (HEAR) movement points out, "there are no regulations governing how loud sound can be in public places such as discos, movie theaters, dance clubs, or exercise centers" (Hearing Education 2004). This seems to have flowed over into the world of performance and education, with little enforcement of safety standards in those environments. Noise ordinances exist not for

hearing health but for mental health reasons. This is evident because measurements for noise ordinances will be taken *outside* of a music venue, for instance. The Right to Quiet Society notes that noise ordinances “may contain a general prohibition against making noise that is a nuisance to other people,” but does not refer to appropriate sound levels to prevent hearing damage (“Frequently Asked Questions”). They are concerned with public disturbances due to involuntary exposure to “annoying” sounds. Studies on noise-induced hearing loss do not consider annoyance; they consider sound safety alone, measured as a function of sound level and time. Dangerous sounds begin at an 85 dB average sound level exposure over an eight-hour workday (“How to Look”). It is at this point that the Occupational Safety and Health Administration begins to enact sound safety regulations (“Hearing Loss”).

For every three decibels over 85 dB that the average sound level increases, it takes half the time for damage to occur (“How to Look”), because of the logarithmic scale. This means that at 88 dB, the sounds are safe for only four hours. Sounds at 106 dB are safe only for 3.75 minutes (See Fig. 7, below, for further details). The National Hearing Conservation Association petitioned OSHA to lower permissible noise exposure limits from the aforementioned 85 dB to 80 dB in November 2009 (about as loud as a vacuum cleaner), in order to align regulations with current research (National). This means that current regulations may still be too liberal, permitting unsafe sound exposure.

At an 85 dB average (under current regulations), OSHA requires the administration of hearing tests and training of applicable employees, as well as hearing protection for any individuals who have experienced a standard threshold shift (STS). Above a 90 dB average, companies must implement engineering controls, and hearing

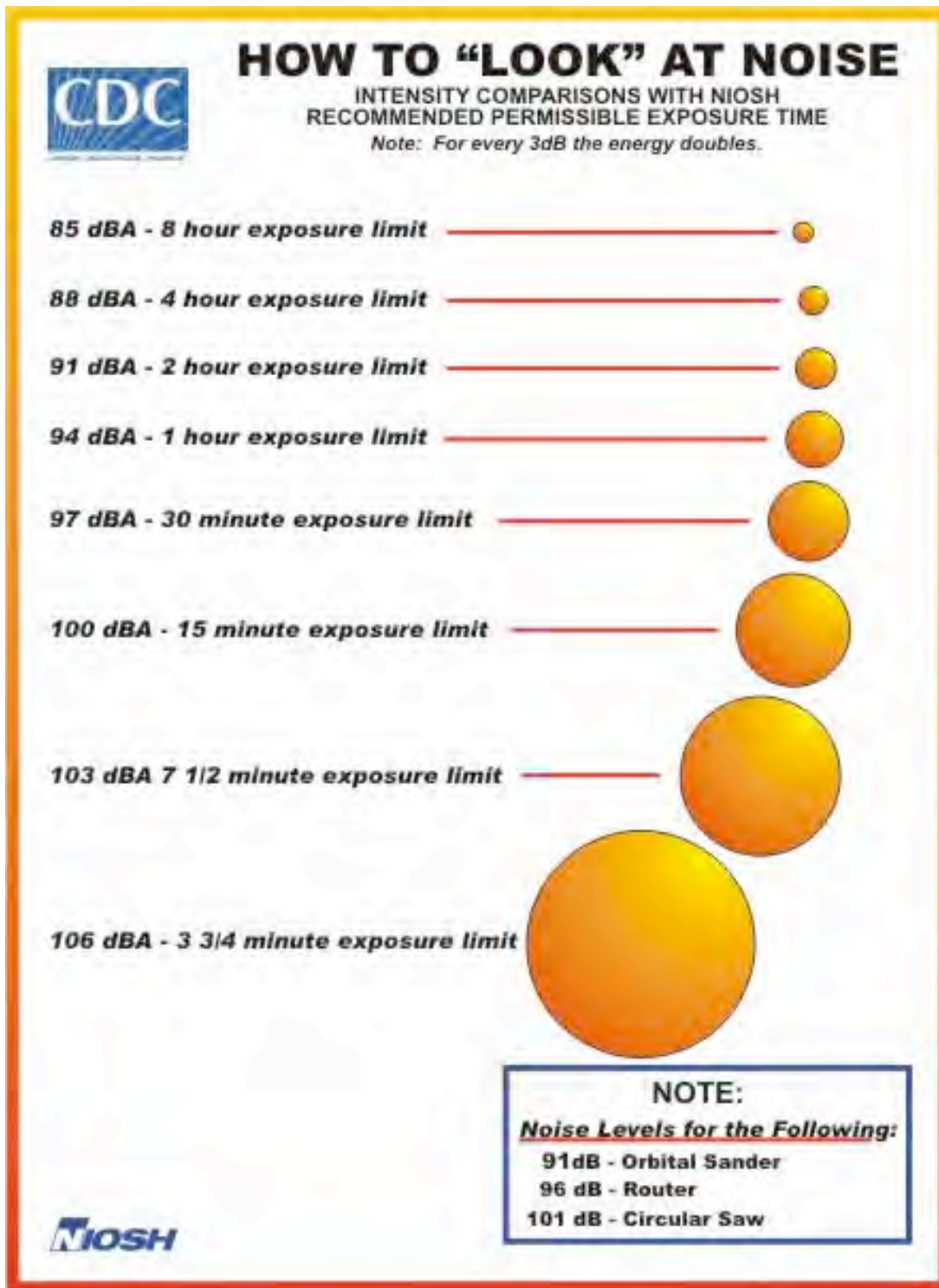


Figure 7. "How to 'Look' at Noise" (NIOSH).

protection becomes mandatory ("Complying"). Engineering controls include modifications of equipment and machinery to reduce its sound output. OSHA regulations

require that a hearing conservation program be established when engineering and/or administrative controls fail to reduce sound levels to a safe average level below 85 dB (Hearing Education 2004). A musical application of “engineering controls” may be far-reaching, but difficult or unrealistic to implement. Unfortunately, there seems to be little recognition of the problem of NIHL for professional musicians in general, despite efforts made by certain organizations.

Many types of institutions that have documentation of NIHL in their employees have implemented hearing conservation programs in order to comply with OSHA standards. Sample hearing conservation programs can be found on the Internet from various sources. There appears to be a typical format that many agencies, institutions, campuses, and centers follow. They simply fill in the blanks that indicate who is responsible for which aspects of the program and for maintaining records. These programs are intended “to prevent occupational hearing loss and comply with the COMM/OSHA Standard CFR 1910.95 – Occupational Noise Exposure” (State of Wisconsin). Elements of a hearing conservation program include noise monitoring, audiometric testing, hearing protection, education and training of employees, and recordkeeping. This is a valuable guide for a school of music to follow in an effort to develop a local program of hearing conservation. This document is not a necessity, but it is a means to an end. By following the guidelines laid out by a sample hearing conservation program, the hearing of students and teachers in a musical setting may be protected. The steps included in the application of a hearing conservation program to the Texas State University School of Music are developed in the discussion of solutions.

MUSICAL HAZARDS

Live, amplified music poses a threat to hearing. Consider that 60% of Rock and Roll Hall of Fame inductees are hearing impaired (Hearing Education, 2006). Un-amplified music also poses a more “low profile” hazard to hearing. Dangerous sound levels occur in band halls, orchestra pits, and private lessons throughout America. According to Hearing Education and Awareness for Rockers, “the incidence of hearing loss in classical musicians has been estimated at 4-43%,” compared to 13-30% in rock musicians (“Decibel Trivia”). The damage that musicians might incur through daily occupational and recreational activities is shocking.

Research suggests that 28 million Americans (about 10% of the population) suffer from hearing loss (Hearing Education, 2006). With as many as 50% of musicians reporting problems with hearing loss (Chesky, K., William, J.), musicians seem to be a much higher risk. However, comparative data regarding the instance of music majors versus non-music majors with hearing loss is not determined. There may or may not be a significant difference in the frequency of hearing loss among the student population as a whole. Still, there is much evidence to indicate the professional musical environment as a hazard to hearing health.

Instruments seem to be the greatest contributor to excessively loud sound levels, although some damage may occur in vocal settings as well (Mace). The NHCA has published a listing of musical sound levels for various instruments. All of the measurements in the chart reflect a range of average decibel levels. Based on these numbers, the piano, violin, cello, oboe, flute, piccolo, clarinet, French horn, trombone, tympani and bass drum all have the potential to put out dangerous levels of sound from

85 to 114 dB. Normal piano practice, a fortissimo singer (from three feet) and chamber music in a small auditorium are the only listed sound sources that do not exceed 85 dB (“Decibel Volume”). (See Fig. 8)

Sound Source	Sound Level
Normal piano practice	60-70 dB
Fortissimo singer 3 ft away	70 dB
Chamber music in small auditorium	75-85 dB
Piano fortissimo	92-95 dB
Violin	84-103 dB
Cello	82-92 dB
Oboe	90-94 dB
Flute	85-111 dB
Piccolo	95-112 dB
Clarinet	92-103 dB
French Horn	90-106 dB
Trombone	85-114 dB
Timpani & bass drum rolls	106 dB
Symphonic music peak	120-137 dB
Amplified rock music at 4-6 ft	120 dB
Rock music peak	150 dB

Statistics for the Decibel (Loudness) Comparison Chart were taken from a study by Marshall Chasin, M.Sc., Aud(C), FAAA, Centre for Human Performance & Health, Ontario, Canada. There were some conflicting readings and, in many cases, authors did not specify at what distance the readings were taken or what the musician was actually playing. In general, when there were several readings, the higher one was chosen.

Figure 8. Musical Sound Levels (Adapted from "Decibel Volume," NHCA).

Music students spend time playing and listening to instruments and voices throughout the day, on top of typical environmental sounds such as traffic and household

appliances. Music degree programs require students to attend ensemble rehearsals and private lessons, spend spare time in practice rooms, and attend concerts and recitals. Rehearsal periods at Texas State University range from fifty minutes for concert and steel drum band, to two hours and twenty minutes for marching band and wind ensemble. The majority of other ensembles rehearse for eighty minutes (“Open Sections”). Symphonic music peaks from 120 to 137 dB (“Decibel Volume”). According to OSHA standards, the permissible sound level for the length of an average ensemble rehearsal (roughly 1.5 hours) is 103 to 104 dB (“Decibel Volume”), not 120 to 137 dB. Of course, a band or orchestra is not playing at its peak sound level for the entire class period; however, these numbers create a distinct cause for concern. Despite the evidence that musical environments may pose a hazard to hearing, OSHA’s primary concern is in dealing with continuous-level industrial noise. Other individuals and organizations must do their best to raise awareness and correct this problem without OSHA’s involvement.

Preliminary research from the Music Research Institute at the University of North Carolina at Greensboro used dose measurements to find that 52% of subjects in a wind band “experience one or more rehearsals a week with sound levels greater than 100% (as defined by the National Institute of Occupational Safety and Health)” (“Music-Related”). Above 100% of NIOSH-defined sound levels means that, based on dosimeter measurements these students are exceeding safe sound levels (85 dB average over 8 hours) in the duration of a single rehearsal. Imagine the state of the conductor, who may stand in multiple rehearsals every day, potentially barraged by over 100% sound levels in a single class period. Ensemble directors are at serious risk of damaging their hearing every day. The many factors that make ensemble rehearsals hazardous to hearing include

the duration of sound exposure, its volume, the acoustics of the rehearsal space, proximity to the sound sources, repertoire choice, and the repetition of specific musical passages.

Current instructors at Texas State have expressed personal concerns about their hearing in relationship to ensemble rehearsals. Saxophone instructor Dr. Todd Oxford, for example, recalls that his rehearsals as a student were “painful at times.” Because of his personal experiences, he worries about his students in similar situations. As flute instructor Dr. Adah Toland Jones discussed her sensitive hearing, she remarked, “I think your generation is in big trouble.” She is concerned about the ensembles she plays in professionally, as well as those that students participate in, including the opera and salsa band. That many of the players in these ensembles intend to step onto the podium someday themselves is somewhat troubling, considering their likely ignorance of potentially damaging sounds. It is largely in the ensemble rehearsal that students train for their careers. Instructors are the greatest role models for music students. Hearing conservation methods need to be incorporated and shared with students as a matter of professional longevity.

Band, orchestra, and choir are not the only situations in which teachers and students use their instruments. Both teacher and student come into an intimate sound environment in private lessons. In private studios, both instructor and student are generally enclosed in a small room (less than 150 square feet) for at least a half-hour per lesson. The schedules of private instructors vary, but many at Texas State University have back-to-back lessons scheduled throughout the day. On the day of our interview, voice instructor Cheryl Parrish described her schedule: “Today, I’ll start at ten, and

instead of having a quiet lunch outdoors somewhere, I'm going to be seated listening to several recital hearings, so I will be in constant sound from ten to five." She teaches 24 students at Texas State University in addition to her in-home studio of about ten students. She notes particular students whose voices make her "feel like [her] ears are shutting down" because of their high intensity output. Her ears, and likely those of other instructors as well, hardly have time to recover from any loud sound exposure. Ms. Parrish correctly states, "I believe that a person can listen too much in one day."

Research from the University of North Carolina at Greensboro established the potential for risk to teachers' hearing in the groups of woodwind, brass, percussion, voice, accompanying, and jazz conducting. At least one study participant from each of these groups had a daily sound dose greater than 100%; remarkably, 100% of participating brass instructors experienced a sound dose over 100% ("Music-Related"). Of the instructors I spoke with, all were aware of and/or concerned about the potential for damage from their instruments. Do the directors share these concerns with their students? Percussion instructor Kari Klier says that she does try to make her students aware of the potentially damaging effects of being a percussionist. Ms. Klier notes that "some are very good about [wearing earplugs]... [but] there are," unfortunately, "still those who think they're invincible." Again, many current music students will spend their lives as private instructors, so conservation of hearing in this musical environment is important as well.

The only part of a student's typical musical exposure that is not mandated by his or her degree is time spent practicing. However, success in a music program necessitates practice. Is the practice room environment safe with respect to sound levels? According

to research from the University of North Carolina at Greensboro, the answer is “No.” Mean sound level doses for 40 students (representing brass, wind, string, and voice) averaged 87-95 dB, with brass players having significantly higher levels. Practice rooms are designed to isolate sound from the outside surroundings; they are not meant to dampen sound enough to guarantee safe sound levels. Individual methods or style of practicing, including time spent and volume used, contribute greatly to the overall sound level. The directors of this study suggest 12-hour breaks (presumably between practice periods) and the use of musician’s earplugs (“Music-Related”). This is an important issue to observe, because long-term hearing should not be sacrificed for current musical success. Musicians must consider the overarching consequences of their behavior.

Intentional steps must be taken to prevent damage to musicians’ hearing. Since most of us do not follow in the lineage of Beethoven, we are not likely to be successful as deaf musicians. Following the guidelines laid out by a hearing conservation program is the most readily available solution, although it may be difficult to implement. Musicians must be made aware that they are at a daily risk of damaging their ears. Only through individual knowledge, awareness of, and concern about noise-induced hearing loss can any change occur.

RISK FACTORS

It is clearly documented that time spent in loud environments is correlated to the risk of noise-induced hearing loss, but other considerations exist as well, including one’s instrument, age, and genes. At Texas State University, music majors are required to participate in an ensemble, which will meet for a minimum of three hours per week (“Open Sections”). Students may also participate in multiple ensembles, if they choose

to do so. Music majors are also required to enroll in private lessons, which typically meet for an hour per week, not including rehearsal time. For instance, at a minimum, I have spent 5.5 hours in ensemble and private lesson rehearsals per week; at a maximum, I have spent 11.5 hours in ensemble and private lesson rehearsals per week. This does not include time spent practicing, performing, or attending performances. I know many other students who also participate in music at a church, play live shows, or attend similar functions. Most students will continue this way of life for many years, regularly exposing themselves to large doses of sound. Because a significant portion of a student's sound exposure is required by his or her degree plan, it is important for the School of Music to take care to minimize the damaging effects of excessive sound in this environment.

Previously-mentioned research suggests that brass players are at higher risk of NIHL than other types of musicians. But the instrument is not the only factor to consider. Along with the instrument comes the music being played and the habits or methods of the player. A student who typically practices for short periods of time at dynamics at or below *mezzo-forte* will likely have much better hearing in the long run than a student who practices for hours at *fortissimo*, regardless of the instrument. Other health problems will probably arise in the case of the latter, making this a practice method to be strongly discouraged. The type of music selected may also influence individual practice habits.

The ability to hear commonly declines with age, a condition known as presbycusis (Dangerous Decibels). However, for a musician, age is also correlated with how many years one has been playing. A person who has been singing and playing several instruments since childhood should be more concerned about NIHL because he or

she has been exposed to noise for a greater portion of his or her lifetime. Likewise, years spent as a career musician, whether teaching or performing, are years spent under tremendous sound exposure. Part of the trouble with NIHL is that it typically occurs slowly over time, and it is therefore practically impossible to pinpoint where damage occurred. It is important to note that some hearing losses are a result of genetic conditions or medication side effects, among other possible causes aside from NIHL. Hearing loss found in students and faculty may be due to causes outside of or prior to enrollment or employment at Texas State University's School of Music.

Research is currently underway to determine if there may be a genetic factor making some more susceptible to NIHL than others. Of particular interest is that in a study of undergraduate music students' hearing at the University of North Carolina at Greensboro, hearing losses in the 4-6 kHz range occur more frequently and more deeply in the right ear than the left, among those with a hearing loss, while this finding is not as pronounced in non-music students ("Music-Related"). Ms. Kari Klier reiterated this finding from her personal experience with hearing problems in her right ear, although not from a genetic stance. She says, "[percussionists] think that it's because the higher parts of the marimba, xylophone, and all that is on our right... A couple of friends and I all have the same issues with the right side." However, NIHL is caused entirely by sound intensity, not frequency.

While several risk factors for NIHL exist, time remains the most significant and modifiable of them. Moderation is the key for hearing health as it is in many other areas of life. Brass players should be especially cautious of their musical habits, although there appears to be no type of musician that is risk-free. Luckily, there are ways of reducing

the risk and changing behaviors. As we look for light at the end of the tunnel, may there be sound at the end of the symphony.

TEXAS STATE UNIVERSITY SCHOOL OF MUSIC

AWARENESS, INTEREST, & CONCERN

Sound levels at Texas State University are likely very similar to those at other universities. Due to time and budget constraints, local measurements were not taken; however, Dr. Thomas Clark, Director of the School of Music, intends to monitor sound levels in some particular School of Music environments in the future. Evidence from the University of North Texas and the University of North Carolina at Greensboro suggests that administrative precautions are necessary to ensure the hearing safety of their students and faculty.

At the newly established *Musicians Forum*, Dr. Clark and I presented information about NIHL to students in attendance. There was a fair amount of interest from these students. When asked if they had experienced tinnitus or a standard threshold shift, the majority of the audience raised their hands to indicate that they had experienced one or both of those hearing problems. Several weeks after this presentation, a peer and part-time disc jockey, Coty R. Morris, informed me that she no longer plays her music at blaring levels. In fact, Morris mentioned a friend who excitedly invited her to experience the way you could “feel the sound go past your ears” in his car. She refused. This response is a distinct change in an individual’s behavior, which shows that simple education can be an effective means of reducing the damage of loud sounds. Based on this anecdotal evidence, there is an obvious need to raise awareness about NIHL in the

School of Music. It is clear that simply doing that can make a difference in individual lives.

Interest levels regarding this subject from faculty were more complex. It became clear during the interview process that those who agreed to an interview were very interested in the subject. The instructors often had personal hearing problems alongside their concerns for friends or students. Further interest was gauged during a presentation at a faculty meeting. Although only a sampling of the music school's faculty was in attendance, there was much attention to my presentation about NIHL and the development of a hearing conservation program for Texas State University's School of Music. The brief discussion that followed brought out many concerns regarding implementation, including some resignation or denial that the music school environment may be hazardous despite the evidence shared. Those with whom I had previously spoken generally remained quiet in their eagerness to implement a solution. As Texas State University's School of Music continues to take steps toward a safer sound environment, the greatest challenge may be that only those in opposition are willing to speak up. It is my hope that those who are eager to live out the solution will find their voices and encourage forward motion toward implementing a hearing conservation program at Texas State University's School of Music.

DESIGNING A SOLUTION

Based on evidence that classical music environments may pose a threat to musicians' hearing over time, we must consider how to reduce relevant risks. Elements of OSHA's hearing conservation programs serve as excellent guidelines for developing a local solution without involving external administrators. A hearing conservation program includes noise monitoring, audiometric testing, hearing protection, education, training, and recordkeeping, if engineering controls have not solved the problem. I have developed seven items for the School of Music to implement to improve the safety of its sound environment. These simple steps include getting local measurements, conducting hearing tests, educating and training faculty about noise-induced hearing loss, sharing that information during rehearsals, making acoustic and environmental modifications, encouraging private instructors to take breaks between lessons, and shortening ensemble periods. There are certain challenges about each of these elements as well, which will be addressed in the conclusion.

1. MEASURE SOUND LEVELS.

Aligning with OSHA's requirement to monitor sound levels, Texas State University's School of Music must obtain local sound measurements. Only when we know what specific challenges we are dealing with can appropriate and justifiable changes be made. Measurements should be taken using a dosimeter in ensemble rehearsals and private lessons. This should be done at the instructor's ear as well as at various performers' ears. After initial measurements have been taken, measurements should continue each semester to ensure safe sound levels over time.

All measurements should be recorded in a single document, similar to *Form #1: Noise Exposure Measurements* [Appendix B], excerpted from a hearing conservation program used in an industrial setting. This includes the location and method of measurement, and the measured decibel level. Efforts to make changes should also be documented here, in order to evaluate the effectiveness of any modification measures. Other similar documents for record management can be found in any sample hearing conservation program.

In order to do this, funds must be in place to obtain a sound level meter and dosimeter. Multiples of these items would be preferable, in order to facilitate simultaneous measurements. Dosimeters would be a more effective tool for School of Music measurements because they read a properly time-weighted average. With a sound level meter, on the other hand, the display numbers constantly change according to the sounds in the environment. This type of measurement would be most valuable for finding out how loud incidental sounds are, so that administrators can pinpoint problems to address.

I suggest that dose measurements be taken during ensemble rehearsals at (or near) the conductor's ear and at (or near) the ear of various students (at least one in every section). Dose measurements should also be taken over a full day for conductors and private instructors. Measurements of sound dose from various students' school days and in one particular room over a day's length may also provide useful information. All of these things will help School of Music administration pinpoint what areas need the most attention.

2. OBTAIN BASELINE AUDIOGRAMS FOR STUDENTS AND FACULTY

The first step to healthy hearing is to figure out one's starting point. Only an audiologist can report exactly how well one hears. According to NIOSH, only 39% of adults have had a hearing test in the last three years ("Noise-Induced"). Of the eight faculty interviewed, only four have *ever* had their hearing tested by an audiologist. Even so, only one of them has their hearing tested with any sort of regularity. An initial audiogram is called a baseline audiogram. A baseline audiogram is especially important for keeping track of aural changes that may occur over time. By having an annual audiogram, it may be possible to pinpoint lifestyle choices that have caused damage and then work toward changing them. Annual audiograms may also be especially helpful when evaluating the efficacy of a hearing conservation program. With healthy hearing, both speech and music should be easily perceptible and comprehensible.

In order to attain the goal of monitoring the hearing of faculty and students in the School of Music, I have initiated contact with Lori Stiritz, M.A., CCC-A, and audiologist at Texas State's Audiology Clinic. The University of North Carolina at Greensboro has been able to coordinate on-campus hearing evaluations for their students, administered by graduate students (trained by an audiologist) and funded by the university; however, faculty are not included in this mandatory and free hearing evaluation (Mace). Similarly, I believe this service should be provided not only for music students but also for at-risk music faculty at Texas State University and paid for by the School of Music or the university, as at-risk employees covered by a hearing conservation program under OSHA do not pay for their audiograms. "At-risk" employees are those who, demonstrated by environmental measurements, are exposed to at least 85 dB averaged over 8 hours in their

workplace. Arrangements should also be made to screen music students' hearing each school semester or year. This allows for a "red flag" of any students with abnormal hearing, who will then be referred to an audiologist. The aim in this situation is to pinpoint problems before they become unmanageable and to encourage preventative behaviors.

3. TEACH AND TRAIN FACULTY ABOUT NIHL.

Making sound levels in the School of Music safer begins with the instructor or conductor of a class. Ask any music student who inspired him or her to pursue music, and I believe that a majority of students would mention a particular instructor they worked with earlier in life. Instructors' range of influence on their students includes health behaviors. When instructors know and believe that their hearing is something to be concerned about protecting, students will be more likely to follow in that belief. It is for this reason that I strongly recommend instructor training. Education is a matter of older, more experienced individuals passing along knowledge to younger, less experienced individuals. When it comes to hearing loss awareness, this is an issue that must be addressed from the top down, from university instructors all the way to elementary students.

Not only should faculty awareness about NIHL be raised, but they should also know the potential hazards posed by their occupation and how the risks may be reduced. This may occur in a variety of ways. Following my presentation at the April 2010 faculty meeting to begin to raise awareness of and spawn discussion about musicians' hearing loss, a more organized training session may be implemented, allowing more time for

active participation. Faculty may also be given informative documents with statistics and ideas for implementing personal change. Additionally, local measurements should be shared with faculty once they have been obtained.

In addition to this oral presentation, personal interviews have opened discussion about this problem. There was a significant level of interest from all participants who volunteered. Of those who did not respond to my request for an interview, the reason is unknown. It may or may not be due to a lack of interest. Based on the faculty meeting, there is a certain amount of indifference and/or denial among the music faculty. Either way, it is important to realize that personal motivations are involved in spreading awareness about musicians' hearing loss.

4. REDUCE THE VOLUME.

Sounds produced by classical musicians are often dangerously loud. The simple solution to this problem is to be quieter. Whoever is the authority figure in the room is ultimately responsible for the volume. But it is only after faculty have been trained about the problem of musicians' hearing loss and possible solutions that we can expect them to use this information. Instructors should share their knowledge and awareness with their students, recommending hearing protection and lower dynamic levels.

Hearing protective devices (HPDs) such as earplugs or earmuffs can greatly preserve hearing and are easy to obtain. Drugstores and pharmacies carry earplugs, as do stores with a hunting department. Every HPD has a number called the Noise Reduction Rating (NRR), which indicates how many decibels the HPD will reduce. Any reduction of noise whether it is 15 dB or 35 dB will extend the amount of time one can be exposed

to loud sounds without causing damage. Having an HPD that fits properly is also very important for effective noise reduction, which is why many wear custom-molded earplugs.

Musicians often turn their noses up at the thought of using earplugs. There is good reason for that. Some earplugs alter the quality of sound rather than just the level of sound. This is especially true of inexpensive foam earplugs. “Musicians Earplugs” and other high fidelity earplugs are specifically designed to reduce noise and preserve sound quality. Custom-molded earplugs typically cost from \$150 to \$200 (Etymotic). They last longer (assuming they are not lost) and are highly effective. I have worn high fidelity earplugs that cost \$18 (Etymotic) and some from Walgreens that cost less than \$5 frequently during ensemble rehearsals and concerts at school without adverse effect. It is important to realize that good earplugs will not destroy musicality or intonation; they will simply lower the volume. Wearing a protective device and/or limiting time exposed to loud sounds are the simplest ways to maintain healthy hearing.

Another potential sound barrier sometimes used in musical settings is called a sound shield. Dr. Adah Toland Jones first mentioned this as she discussed her experiences as flautist in the pit for the Austin Lyric Opera. Unfortunately, research from the University of North Carolina at Greensboro has demonstrated the ineffectiveness of sound shields at bringing sound levels in music ensembles down to a safe level (“Music-Related”). Earplugs remain more effective at bringing sounds to safe levels.

Individual behaviors reflect one’s ideals about sound. Conductors may promote better use of dynamic levels in their rehearsals, but each one must believe this change is both important and possible in order to be effective. A conductor who never addresses

dynamic levels is probably more concerned about intonation and articulation than with healthy hearing. If conservation of hearing were a more important value to the conductor, he or she would be more likely to encourage his or her ensemble to play at lower dynamics until later on in the rehearsal process. In the same way that opera singers will ‘mark’ during rehearsals in order to conserve their voices for the rigorous work ahead, other musicians should also reserve their loudest dynamics for real performances in order to conserve their hearing. Ensembles that practice in this manner may also become more musically energized and sensitive when the playing volume is not consistently *forte*. Once implemented, I hope that this attitude and style of teaching will be passed on through generations of musicians.

5. MODIFY THE PHYSICAL ENVIRONMENT.

Building structure, room surfaces, and furnishings are primary contributors to the resonance of an environment. Practice and performance spaces are often created with specific acoustic goals in mind. In a concert hall, for example, the acoustician hopes to achieve an equal dispersion of sound in every seat in the hall with maximum clarity of sound. In a practice room, the acoustician hopes to isolate sound from the outside and maintain its accuracy within a small room.

An expert should give specific recommendations for materials, but simple changes can be made to improve the safety of any sound environment. For instance, adding carpeted surfaces or drapery can dampen sounds considerably for both performer and observer. Acoustic paneling is included in most rooms intended for use as musical settings, to reflect and absorb sounds for optimum quality throughout the room.

In some School of Music classrooms, Dr. Thomas Clark believes the existent acoustic paneling does not sufficiently dampen ensemble sounds to safe levels. One room, MUS 216, seems particularly dangerous in terms of its acoustics. Dr. Clark successfully scheduled a maintenance request for this room, to include 780 sq. ft. of fire-resistant sound-dampening curtains, 3,100 sq. ft. of sound absorbing panels, and 2,000 sq. ft. of suspended acoustic ceiling tiles. The renovations on room 216 are estimated to cost a total of \$49,700 (Clark). Clearly, these types of physical modifications are very costly. Non-construction options for reducing sound levels should be seriously considered in light of this information.

While the design of the room is important, the proximity of the ear to the sound source (instrument or voice) is incredibly important as well. Without the aid of any resonating space (as in an open field), sound levels decrease by a factor of four with every doubling of the distance from the source (Inverse square law) (Matyear). Moving a conductor a few more feet away from the band or orchestra, then, may be beneficial to his or her hearing.

Placement of students and their instruments is something to consider as well. Dr. Adah Toland Jones, Texas State flute instructor and member of the Austin Symphony Orchestra says, “we’ve tried every kind of way we can sit with my flute in front of [another flautist] or behind her,” trying to eliminate the harshness of another instrument so near to one’s ear. More consideration should be given to this problem in an educational setting, as in the ASO. There are clearly many elements to consider in the realm of acoustics, and in this section I have lightly touched on this very complex

subject. A professional should be consulted for advice about any serious acoustic modifications in the School of Music.

6. REQUIRE BREAKS FOR PRIVATE INSTRUCTORS.

We have already seen that time exposure significantly impacts overall sound levels. Shortening the length of exposure to loud sounds dramatically improves the safety of the listening environment. Admittedly, the sounds that occur in the School of Music environment are unlike those of a factory, for instance, in that the sounds are often intermittent and vary in volume, whereas sounds in a factory essentially remain constant throughout the day. Even so, it is possible to exceed 85 dB (average) during an eight-hour workday in a private studio. If the average is much louder, the safe time decreases considerably. (See Figure 7, p. 14 for additional decibel-to-time safety comparisons.) Conversely, incorporating periods of silence into the workday may bring significant improvement to the safety of the private studio environment. Periods of silence may allow the ears to recover from over-exposure. Faculty concerns about their hearing health in relation to the fullness of their schedules should be addressed by administrative action.

For these reasons, I recommend that five- to ten-minute breaks between students be required for private lesson instructors. In environments of constant sound, periods of silence make a great difference. While one hour of sound may average out to 110 dB, fifty minutes at 110 dB averaged with five minutes of silence at 0-20 dB, brings the sound level for that hour down to 90-92 dB. Although periods of silence do not guarantee safe sound levels, they do decrease the harmfulness of dangerous sounds.

Monitoring this practice will be troublesome. Instructors must take the initiative to keep an eye on the clock and come to a stopping point at the appropriate time. Their schedule should run like other classes, ending five or ten minutes before the next class begins to allow a passing period for students. In my experience with voice lessons, I have frequently started lessons late because the previous student was still rehearsing and have also often left late as I tried to solidify what I had learned that day (often causing me to be late to my next class). This is undoubtedly a common problem in the School of Music that will be difficult to change. It is in the nature of private lessons to want to continue working until the student reaches a goal, but the habit of running late and not taking breaks may be detrimental not only to students' attendance records, but also to the instructor's ability to hear.

7. DECREASE ENSEMBLE REHEARSAL LENGTHS.

Ensemble rehearsal lengths currently vary from 50 to 140 minutes ("Open Courses"). We need to measure the average sound level and ensure that it is not over 91 dB, because if so, the sound has entered the hazardous range for a two-hour period. If a student or conductor has back-to-back ensemble rehearsals, for instance, the level of allowable sound will be much lower. The goal of making ensemble rehearsal periods shorter is in order to accommodate the existing loud sound levels. Making the period of exposure shorter should make current sound levels safer. This change is as much for the conductor's safety as it is for the safety of students.

CHALLENGES

Many of the proposed solutions come with distinct challenges for implementation. Although administration is largely involved, every individual must take responsibility for his or her own health. The challenges range from finances and schedule conflicts to privacy and liability. I will discuss the difficulties associated with each of the seven steps previously delineated, in order.

In order to measure sound levels, a person must be assigned the task and funding will be needed for the attainment of new equipment, namely dosimeters and sound level meters (as many as deemed necessary). The person measuring must be trained about how to properly use the equipment. This may require hiring someone outside of current School of Music employees on a contract basis.

Getting audiograms through the Audiology Clinic at Texas State puts an immense load onto the lone campus audiologist, Lori Stiritz. Scheduling, funding, and motivation are the main challenges with implementing hearing evaluations. University funding may be necessary to obtain hearing tests for appropriate faculty members and screenings for students. Typically, audiograms on campus cost \$80 without insurance coverage; however, hearing tests to satisfy OSHA requirements are simplified, testing only pure tones (not speech), and costs \$20-30 without insurance. (Insurance may be applicable.) There are no regular discounts for faculty, staff, or students. Additionally, custom-made Musicians Earplugs (as made by Etymotic or Westone) have a base cost of about \$110 from the manufacturers, which would be purchased at the patient's discretion. (Stiritz).

Other points to consider in regards to audiological testing include the timing of evaluations. Will music faculty and students schedule their own appointments or will

School of Music administration schedule for them? Audiometric equipment as in the Audiology Clinic is not portable, so patients must report to the Health Professions Building for testing. Stiritz does not perform hearing screenings, as it is not an effective use of her time and skills. The University of North Carolina at Greensboro has developed a unique strategy. Utilizing graduate students to perform the examinations, they administer tests two hours a day, four days a week, for seven weeks. During these seven weeks, students sign up for an examination time designated according to their ensemble, and the test is required for completion of the course. They have found this to be a successful way to have all music majors' hearing evaluated (Mace). As a precaution, administrators must assure faculty and students that the results of a hearing evaluation or screening have no bearing on job qualification, retention, admission, graduation, or certification. Faculty and students should be evaluated based on musical ability alone and not discriminated against because of any level of disability.

When it comes to teaching and training faculty about musicians' hearing loss, many logistical concerns come to mind. Will there be formal training sessions? When will they be, who will lead them, and what will they content consist of? How will the effectiveness of training be evaluated? How will the School of Music ensure faculty attendance? What will be the consequences for not being trained about NIHL? Thankfully, a large number of music faculty attended a lecture based on this thesis topic; therefore, a piece of the education has begun.

The use of earplugs may be a source of great debate. In my experience as a vocal musician, I have often used musicians' earplugs during rehearsals, although usually only in one ear at a time. My hearing condition is very unique, of course, but I did not find

that the use of earplugs affected my musicianship positively or negatively, although it did ease my agitation at loud sounds. Many of the professors I spoke with expressed concern that the use of earplugs in a musical environment will be detrimental to the musical product because of potential balance and intonation issues. According to research at the University of North Texas, earplugs pose a challenge “in environments that are both loud and require verbal interaction” although subjects “generally liked the [high fidelity Etymotic] earplugs and thought they were valuable” (Chesky, Evaluation). Another problem with earplugs is in their proper use and individual comfort, but “responses to comfort questions were variable” in a study (Chesky, Evaluation). In order to alleviate complaints, I would suggest that individuals use them for only a portion of a rehearsal, rather than for its entirety. If particularly loud moments are known, hearing protection may be specifically recommended during those segments of music. Other issues with earplugs include individual responsibility for payment and possession. Musicians’ earplugs may be included on the required materials list given to students at the beginning of the semester. Much like bringing a pencil to rehearsal or shin guards to soccer practice, earplugs should be considered a necessity.

The suggestion to rehearse at lower dynamic levels may bring some objection because of the idea that individuals should always practice the way they will perform. However, a good musician can adapt to his or her environment at a moment’s notice. Every performance and rehearsal space is different, and we should always play appropriately for it. Doing so includes using lower dynamics when in more confined spaces. The challenge is that care must be taken on the part of the conductor and his or her ensemble to ensure that lowering dynamics does not sacrifice, but rather vitalizes,

musicality. Another challenge is that some instruments have a “lower limit” on their dynamics, meaning that they are very difficult (or impossible) to play properly at low dynamics. For these instruments, we must be sensitive to their technical needs and find other ways to improve the safety of the sound being produced.

Changing the physical environment creates further obstacles. Any permanent modifications to university property will require an official work order and funding for its implementation. The School of Music will also need to refer to an acoustician and possibly an architect to ensure that any recommended modifications meet safety codes and will fulfill the school’s needs for sound safety enhancement. With the construction of a new music building in the making, administration must also consider the priority level of modifying the acoustic environment at the current music building (as a new one is planned for construction), and whether such modifications would be an appropriate use of time and funding. Additionally, if the installation of carpeting is seriously considered, the issue of draining saliva from instruments may be an obstacle without an acceptable solution.

The other suggestion as far as modifying the environment was about increasing the distance from sound source to recipient. Yes, a conductor can step a bit away from the ensemble, but only as far as the space permits. The conductor’s proximity may also affect ensemble sound because of the changed level of intimacy or intensity. The arrangement and placement of students also has a distinct effect on an ensemble’s sound, so there are limited options for change based on the space, the sound, and practicality; nonetheless, rearranging an ensemble is an option to consider. A flute, trombone, or trumpet may easily resonate near the ear of another student, but a slight change of

position or spacing may create a safer environment. A factor that cannot be controlled is related to the construction of individual instruments. The resonating chamber of the violin, for instance, is only inches away from the player's ear. These elements must be considered as we aim for a solution to the problem of musicians' hearing loss.

Required breaks between private lessons will be a challenge to monitor. As it is a goal of private instructors to effectively use every possible minute with a student because of the low frequency of lesson times, the expectation that applied teachers take breaks between lessons will be difficult to enforce. Nonetheless, the expectation and recommended compliance would be a step in the right direction. It then becomes an individual choice to accept or reject a well-informed recommendation. The difficulty will remain that half-hour or hour-long lessons do not allow enough time for much accomplishment. Firm schedule restrictions, however, may bring about a change in motivation, productivity, and efficiency.

The same is true of shortening ensemble rehearsal periods. Objections to having briefer rehearsals will undoubtedly mention the inefficiency of shorter, more frequent rehearsals. The time spent setting up, warming up, and tearing down will take away a larger percentage of the rehearsal in a shorter period. Ensemble rehearsal periods are also well established in the schedule for their time slot. Any change would require a dramatic adjustment to faculty and student routine. Other scheduling conflicts may arise if rehearsal times must change, which make this solution very difficult to implement. However, the importance of allowing the ears some time to rest from sound remains. An alternative may be to include a five- to ten-minute break halfway through (or before the damaging time limit, based on measurements, within) every rehearsal. Adjustments to

time exposure are no less effective due to their administrative difficulties; they are merely more challenging to enact.

It is clear that all of these suggestions come with distinctive difficulties. However, I hope that it remains evident that each proposed solution is a viable option. Solving the problem of musicians' hearing loss in a school of music setting requires that initiative be taken by all people involved. Despite the challenges pointed out in the previous paragraphs, possible negotiations have also been outlined.

INDIVIDUAL RESPONSIBILITY

Responsibility for this issue does not lie solely with School of Music administration. Having normal hearing does not make a person safe from potentially damaging sounds. Neither does having damaged hearing. All people are equally susceptible to the damaging potential of certain sounds. Because of this, it is necessary for all people to practice personal moderation. An easy way to tell that a certain environment may be too loud is if you have to raise your voice in order to be heard by a person about three feet away (“Hearing Loss”). Other clues that an environment is dangerously loud are if you experience tinnitus, a threshold shift, or feel like everything sounds muffled during or after an event. However, it is still possible that permanent damage may have been incurred after such events. There is no way to know if tinnitus or a threshold shift is temporary or permanent. There is no rule about how much exposure causes a permanent change; it varies from person to person and is affected by things like other factors that cause hearing loss (i.e. taking a medication that may cause a hearing loss).

In such cases, it is best to lower sound levels by whatever means possible. For instance, it may be a matter of turning down the background music or asking everyone in the room to lower their voices. When you do not have such direct control, you still have choices about how to handle the environment. You can choose to stay or you can choose to leave. You can allow the sounds to continue at loud levels or you can wear earplugs.

Dangerous sounds abound. There is ample evidence about the damaging effects of amplified music, whether at a rock concert or through earbuds. Other everyday sounds that may cause damage come from construction, traffic, machinery, appliances, and even

some children's toys. Much of our daily sound dose comes from these and other sources, many of which are beyond our control. However, because the School of Music is an occupational setting, care should be taken by administrators and employees to ensure that sound levels remain safe and in control. Ultimately, it is each person's own responsibility to take whatever precautions necessary to conserve his or her hearing in much the same way individuals may choose to protect themselves from skin damage with sunscreen. Only when the individual recognizes loud sound as a personal concern will behavior change.

CONCLUSION

Musicians' hearing loss is a real threat to an individual's career. Much evidence has been given to support this conclusion, including personal opinions of Texas State University School of Music faculty. All musicians should be concerned about the potential loss of their hearing and should be motivated to preserve it throughout their careers. They should also encourage future generations to feel and act similarly. Noise-induced hearing loss is preventable. Individual attention to the sound environment and awareness of hazards is a large part of the solution.

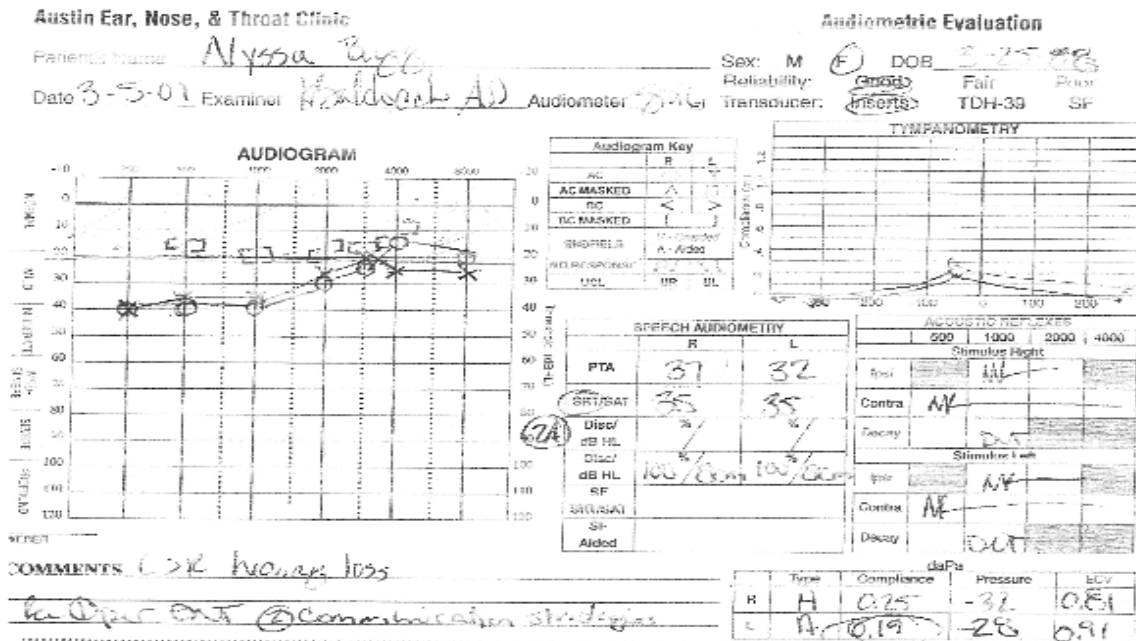
Keeping in mind the three most potentially dangerous sound environments in a school of music setting (ensemble rehearsals, private lessons, and practice rooms), let us recall the possible solutions. The School of Music should monitor sound levels, get audiograms for faculty and students, train and educate personnel about musicians' hearing loss and NIHL (as well as the delineated solutions), encourage use of earplugs, rehearse at lower dynamics, modify rehearsal environments to absorb more sound, increase distance from the sound source, take breaks between private lessons, and shorten ensemble rehearsals or incorporate a break in the midst of rehearsal. Records should be kept of all action taken towards a solution in order to evaluate the effectiveness or ineffectiveness of each measure. These suggestions are in line with OSHA standards for hearing health in a work environment.

It is my hope that the information contained in this document will lead to the development and implementation of an official hearing conservation program in Texas State University's School of Music. By beginning to raise awareness and conserve hearing at the university level, generations of future musicians may also retain their

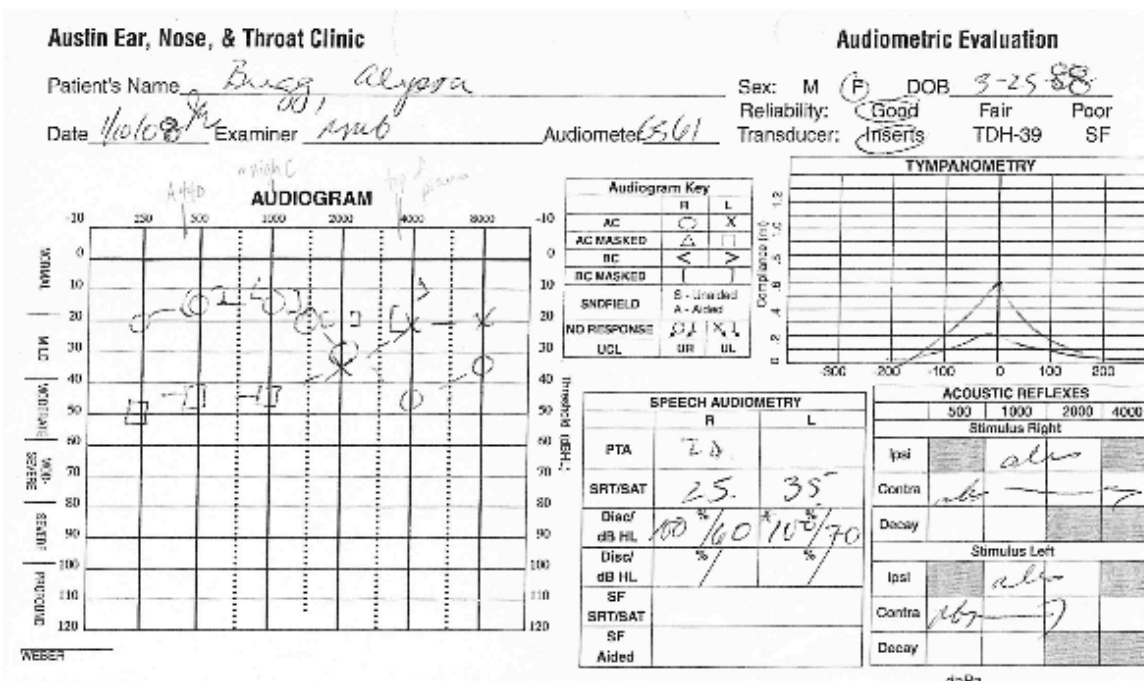
hearing for successful lives and careers. Should individuals lose their hearing, let it not be due to a workplace or school setting. Let individuals make their choices, but make every effort to prevent hearing loss caused by necessary daily occupational activities.

APPENDIX A: PERSONAL AUDIOGRAM

1. Pre-stapedectomy hearing (5 Mar. 2007)



2. Post-stapedectomy hearing



Noise Exposure Measurements

Organization:_____

[illegible]

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