Abstract

The health hazards associated with noise exposure warrant that it be recognized as a serious form of environmental pollution, one that threatens the health and well being of all Americans. It is the purpose of this paper to discuss noise pollution, specifically what is produced by the commercial transportation industry and the diesel engine trucks crowding interstates and highways across America. Noise pollution due to diesel engines and its impact on areas of urban expansion, as well as health problems associated with noise exposure will be discussed. Excessive noise produced by commercial transportation becomes increasingly problematic as urban populations grow and metropolitan areas expand, absorbing neighboring towns and rural areas in their wake. There currently exists no regulatory legislation on the federal level for such noise pollution, and as the populations of metropolitan areas increase and they expand into outlying areas, noise pollution threatens to help destroy the physical and mental health of people in rural towns and agricultural communities who may have no choice but to stand silent and listen as their once quiet area develops into a noisy city. This noise encroachment not only represents a continued risk for the health of city dwellers, but threatens a long-continued way of life of those who live in these recently developed areas. In the hopes that this paper will generate awareness throughout the educational community as well as the transportation industry, possible solutions will be presented including the application of audio technology as a means of reducing diesel noise. Engineering education is an ultimate field for providing an optimal scope of disseminating the advancements of this technology. By educating future engineers, the importance of discussing environmental topics such as this in class as well as creating projects with it outside the classroom will encourage industrial collaboration for viable alternative solutions of increasing problems with rural growth.
Introduction

Noise is a problem that has bothered human civilization since the beginning of time. It may have first been viewed as a problem when a pack of wolves howling in the night prevented cavemen from getting a good night’s sleep. Since then, noise pollution levels have increased in direct correlation with the advancement of technology, and the development of industry in the last 200 years has sent environmental noise levels through the roof. In modern society, we are constantly bombarded by noise of all sorts, and although we may not easily recognize the adverse effects of these high exposure levels, studies show that there is a multitude of health risks involved with environmental noise. These include both temporary and permanent hearing loss, communication impediment, sleep disturbance, increased stress hormone production, and disruption of concentration, as well as adverse effects on blood pressure\(^1\).

The World Health Organization and the EPA both recognize environmental noise as a health hazard, and in fact the EPA at one time had an Office of Noise Abatement and Control (ONAC), which was created after the enactment of the 1972 Noise Control Act. The office was created to research the problem of noise pollution and to seek possible solutions to the increasing noise of American towns and cities. In 1981, however, under the Reagan Administration, funding for ONAC was cut and the office was abolished. Since that time there has been very little progress in the effort to regulate noise pollution.

Although high levels of noise may commonly be associated with big cities and metropolitan areas, perhaps more adversely affected are the small outlying towns that are found in close proximity to urban areas. These small towns are subjected to high levels of noise from the aircraft and automobile traffic associated with the commerce of large cities. For the residents of these towns, the problem will inevitably worsen as urban populations continue to increase and metropolitan areas expand. This situation can be observed on the outskirts of any city throughout the industrialized world, and consequently the health hazards associated with noise exposure are becoming more significant around the world.

Targeting individual sources of environmental noise has proven to be a difficult task, but modern technology may provide the means to decrease the levels of traffic noise in urban/rural interfaces as well as in large urban cities. Several companies now are developing technology that has the capability of eliminating unwanted noise of many sorts. Commonly referred to as noise cancellation, after the company who has pioneered the technology, Noise Cancellation Technologies, Inc., it is proving useful in a wide range of applications. Testing has been underway since the late 1980’s, but the technology has not yet found its way into the automobile industry on a large scale. The use of noise canceling devices on automobiles, specifically diesel transportation vehicles, could result in significant reductions of environmental noise in urban/rural interfaces.

With a renewal of this information throughout topics taught in the classroom, students will be able to pursue goals that are enriched with technologies that extend past what might be available and expected at the present time. New insightful gains such as this,
formulated by ideas of sustainable design in mechanics, will enable an exponential urban sprawl to commit itself to a nurturing environment. Creating a real-life project from this as part of the course makes the future of engineering and engineering technology education enhanced through becoming aware of this problem. Therefore, the alternative solutions may be formed as engineering students can contact the industries for help with projects involving actual scenarios and enhance their education with the benefits of this win-win situation.

Noise and human health

New studies in the field of noise research are showing that health risks associated with noise exposure are more significant than one might expect. Researchers at the Karolinska Institute in Sweden announced in a recent press release that “long known to cause hearing loss or insomnia, loud or disturbing noise can also induce stress, which in turn leads to increased risk of heart disease." Studies carried out by other scientific organizations are showing similar findings. The direct association of noise and human health is not widely researched, but the WHO has produced an extensive document on the subject, in which researchers stated that there has been a tendency for blood pressure to be higher among persons living in proximity to airports and on streets with higher levels of traffic noise than among control subjects.

These findings are only the newest on a long list of known risks of noise exposure. In the same WHO document, titled Community Noise, it is stated that noise has many adverse effects on human communication such as problems with concentration, fatigue, uncertainty and lack of self-confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of reactions to stress. These adverse effects are of particular importance when considering young children, for whom a quiet learning environment is essential. The EPA recognizes this fact just as parents around the world do, and in a 1978 document stated that because they are just learning, children have more difficulty understanding language in the presence of noise than adults do. As a result, if children learn to speak and listen in a noisy environment, they may have great difficulty in developing such essential skills as distinguishing the sounds of speech.

It is difficult to ignore the fact that noise can at times be a serious problem, as with learning environments for children. Similarly, it is easy for anyone to recognize instances in day-to-day life when noise has adverse effects on health, such as annoyance and irritability due to noise from a nearby construction site, or a headache caused by a neighbor’s loud stereo. However, it is also difficult to quantify exactly to what extent human health is adversely affected by environmental noise. It is this problem that ongoing research will hopefully begin to resolve, providing a more solid backbone for the case against noise pollution. It is doubtful that anyone would disagree that if environmental noise levels were reduced across the board, our environment would be much more conducive to both mental and physical health.
Traffic noise and urban expansion

It is widely agreed upon that one of the primary sources of environmental noise is the ever-increasing amount of traffic on roadways around the world. This is especially true in urban areas and their neighboring communities, through which pass high numbers of commercial transport vehicles as well as commuter vehicles. According to the United Kingdom Noise Association, traffic noise accounts for 66% of the total noise generated outside dwellings in the UK, with 32 million people being exposed to high levels of noise (55 - 75 decibels) \(^4\). Similar conditions can be found in the United States, as well as in many other parts of the world. As urban populations increase and the number of vehicles on the road continue to increase, the problem will undoubtedly worsen.

There are many factors that affect the level of noise produced by traffic systems, but one of the most significant is the number of diesel engine vehicles occupying the road. In a document produced by the U.S. Department of Transportation (USDOT), it is stated that the sound produced by one such truck is equivalent to the sound produced by 32 passenger cars \(^2\). In areas where cities are expanding and assimilating small outlying towns, the increase in commercial truck traffic can often mean a dramatic increase in the unwanted noise produced by major roadways. One such case was recently documented by a study conducted by a graduate student at Middle Tennessee State University, in the town of Mt. Pleasant, TN. The town had begun to lose business in their downtown district due to high volumes of truck traffic and the noise produced by the traffic. According to the study, it was found that the estimated day-night sound level of 70.645 dB exceeded the noise level recommendations set forth by the EPA \(^5\).

This problem exists across the United States as well as in countries around the world. In India, rapid population growth and the subsequent increase in commercial traffic have resulted in dangerously high noise levels. In the Indian publication *The Day After* a recent article revealed that ongoing studies show that the daytime average street noise level in Delhi and Mumbai, for example, is, in most cases, excessively high, being over 90 decibels in some cases and seldom falls below 60 decibels \(^6\). These levels are higher than those recommended by the EPA in the United States, although they may not be much worse than what can be found here in America. It is certain that the problem of traffic noise is one that becomes more significant as modern civilization progresses, and the need for preventative action is becoming increasingly pressing as time passes.

Noise canceling mufflers

Traffic noise does not only consist of the sound generated by engines, it also results from the contact of vehicles tires on the road surface and the friction produced as the tires roll. However, in the case of diesel engine vehicles, the noise generated by the engine is the primary source of noise pollution. Although the effectiveness of traditional mufflers has improved greatly as a result of modern technology, they still utilize a relatively primitive method for reducing the noise produced by an internal combustion engine. The process, simplified, uses a series of sound dampening chambers through which the engine’s exhaust is forced in order to absorb sound waves. Compared to a vehicle without a
muffler, the reduction of noise is drastically improved, but the sound is by no means eliminated.

Technological advancements in the last twenty years have given rise to a new type of muffler that has great potential to reduce environmental noise created by automobile traffic. In the late 1980’s a small company named Noise Cancellation Technologies, Inc. developed a system that does precisely what their name implies; cancels noise. Electronic, or active, noise reduction technology uses sophisticated digital signal processing technology and software for high-speed analysis of selected, undesirable noises in a chosen environment. In the case of noise cancellation, this type of processor uses a microphone to read the wavelength of sound produced by the targeted noise source, and creates sound which has the exact inverse of the unwanted sound waves. This anti-noise is broadcast by a series of speakers that are positioned to intercept the noise.

The technology was initially designed for use on the large vacuum machines used to empty railcars loaded with grain, and was found to be highly effective, reducing the deafening roar of these vacuum machines by 80%, according to a 1991 issue of Automotive Engineering, which discussed the possible application of this technology on automobiles. Logically, Noise Cancellation Technologies, Inc., which has since changed names to NCT Group, Inc., was quick to recognize the potential and began testing on automobile engines, including diesel engines. According to the same Automotive Engineering article, the testing resulted in moderate success, reducing the noise of a 336 kW Detroit diesel engine from 123 dB to 81 dB. NCT, Inc. also joined with Chrysler to produce a demo of an active engine mount on a 4-cylinder engine, resulting in decreases greater than the expected 20 dB, and in fact observed reductions ranged from 22 to 43 dB between idle and 5000 rpm.

The technology of these noise-canceling devices has no doubt increased since the late 80’s, and if implemented in the commercial transportation industry could be a major step in the effort to reduce traffic noise. If these devices could be made cost-effective for widespread use in diesel engine transport vehicles, then the reduction of unwanted noise on roadways would be dramatic. Another potential advantage of these “active mufflers” is that they eliminate the need for a traditional muffler, which in turn eliminates the backpressure necessary to force engine exhaust through the muffler. This results in higher fuel efficiency, as with the aforementioned vacuum machines, in which fuel efficiency was increased by 25 %. A fuel efficiency increase of even a fraction of this would be sufficient to offset a great deal of the cost of the device itself. This alone would be a great benefit of the widespread application of active mufflers, but the reduction of environmental noise possible by the use of these devices presents a viable solution to a pollution problem facing much of the world today.

Engineering applications

The peace sought by humans may come in many different forms, but the comfort found in reasonable noise accumulation is almost unsurpassed. Without the technologies exemplified in this paper, mechanical dominance of the sound waves will continue to try
the calm of temperaments throughout rural areas and the city alike. Worldwide awareness is reason to spark this topic into an abounding collaborative effort. The ASEE international conference is excellent for the development of solutions to target this spreading problem. Initiatives must be taken in industrial and developing countries to ensure that peace of mind can still be found at the end of the day.

Classrooms are superlative for the culmination of ideas that rise from the inspiration of others’ work, such as the innovative noise canceling mufflers. Education of future engineers should focus on rising problems in our expanding world, tailoring the mechanics of engineering fundamentals to fit the needs of society. Industrial involvement with action taken on extracurricular classroom projects will help the students while also providing a new venue for industrial improvement of manufacture. Industries are finding more and more benefits with conscientious environmental ideas. This makes for a great collaborative effort: industries profit with new ideas to market from the enhancement of engineering and engineering technology education for a better environment. Thereby, introduction of this material to engineering classrooms will facilitate more solutions than one for the negative aspects involving environmental development.

One such class at Middle Tennessee State University in the engineering department is called Pollution Control Technology, wherein papers are written about various topics of environmental distress. This in itself attends to a proliferation of educational wealth. However, steps further taken with these opportunistic gems include submission to the ASEE conference and the integration of certain papers’ themes into future semester curriculum. Throughout this course, various topics are introduced including ones recently brought to light by the papers. Other universities may educate their students in this manner, networking topics found elsewhere along with their own papers’ subjects. Then each class can have an extracurricular project of their choice to tackle, and actually apply their education to find alternative solutions for problems we now face, and help integrate that toward environmentally-friendly industrial influence.

Conclusion

With noise canceling mufflers there exists enormous potential for the improvement of human health as a result of decreased environmental noise. It seems strange that we have not already begun to experience the beneficial effects on roadways across the United States and around the world. The technology has found its way into the automotive industry in the form of cab-quieting devices, but the advantages of canceling external noise seem much more far-reaching than those of a quiet automobile interior. Active mufflers have been utilized minimally in the realm of commercial transportation and diesel truck engines, but could no doubt be beneficial on a much larger scale.

Although this sort of technology is not particularly new, knowledge of its existence is only now beginning to reach the public on a large scale. As more people become aware of the potential of these devices, interest in them will certainly increase. Urban areas across the globe could benefit greatly, and the reduction of traffic noise would be appreciated especially by the people living in areas that once were quiet rural towns but
are now being overrun by traffic and traffic noise. Public awareness of what technology has to offer depends partly on education systems throughout the world, and although the subject of active noise cancellation is one that continues to be researched, it remains a relatively little known subject for most citizens of America and of the world.

The health of humans in all modernized countries is at serious risk from the ever-growing drone of noise created by progress, and by the vehicles that make it happen. The problem continues to worsen, and one of the most important parts of initiating change is to raise public awareness of both the health hazards associated with environmental noise and the possible solutions that could make a world of difference. The opportunities found in engineering classes, workshops, and industries will shape the future by encouraging solutions with material such as that mentioned in this paper. Proliferation of engineering projects will allow an expedited amount of problems to be solved. Our environment is the very pedestal from which we will raise our future generations. In America as well as in other countries, many people value the tranquility of the small towns they choose to call home, and the way of life provided by rural towns is in jeopardy of being lost.

Bibliography


Biography

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Saeed Foroudastan is a Professor in the Engineering Technology and Industrial Studies Department. He received his B.S. in Civil Engineering (1980), his M.S. in Civil Engineering (1982), and his Ph.D. in
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