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Leveraging ABET Accreditation to Promote Inclusion of Noise Control Engineering Concepts in Engineering Programs

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ABSTRACT

Accreditation Board for Engineering and Technology, Inc. (ABET) accreditation is an internationally recognized system ensuring consistency and quality in engineering education programs. As a part of ABET accreditation, there is no set requirement for any general engineering program to include noise control engineering concepts in their curricula. However, one of the seven student outcomes that each ABET accredited engineering program must document is their students' "ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare…" Controlling noise in the authors' view is a fundamental strategy for protecting workers from occupational noise and the public from the harmful effects of environmental noise. This presentation provides an overview of ABET accreditation and how INCE can promote inclusion of noise control engineering concepts in engineering programs by leveraging ABET safety and health criteria requirements. Several suggestions for appropriate inclusion of noise control engineering concepts into curricula will be outlined. Additionally, the authors will present synopses of lesson plans that include noise control as a means to address the ABET public health, safety and welfare requirements. The end goal of such efforts is to promote the understanding and practice of noise control across a variety of engineering disciplines.

1 INTRODUCTION

The implementation of engineering noise controls to protect workers from the harmful effects of noise is a requirement of the U.S. Occupational Safety and Health Administration (OSHA). Specifically, 29 CFR 1910.95(b)(1) which covers General Industry states that when workers are exposed to noise levels at or above permissible exposure limits, feasible administrative or engineering controls shall be utilized. Regulations for the Construction Industry are similar (see 29 CFR 1926.52(b)).

In addition to OSHA compliance, there are many good reasons to implement engineering noise controls. Consider these facts from the National Institute for Occupational Safety and Health (NIOSH) Occupational Hearing Loss Surveillance page (https://www.cdc.gov/niosh/topics/ohl/):

- In the United States, hearing loss is the **third-most common** chronic physical condition among adults after hypertension and arthritis.
- About **12%** of the U.S. working population has hearing difficulty.

- About **24%** of the hearing difficulty among U.S. workers is caused by occupational exposures.
- About **8%** of the U.S. working population has tinnitus ('ringing in the ears') and 4% has both hearing difficulty and tinnitus.
- About **22 million workers** are exposed to hazardous noise each year.

Despite the fact that OSHA requires implementation of feasible engineering controls, personal protective equipment (PPE) has traditionally been relied upon to address noise in the workplace. Unfortunately, this strategy often fails due to poorly chosen, or incorrectly/sporadically worn hearing protectors. To emphasize this point, consider that about 31% of noise-exposed Construction workers and 24% of noise-exposed Manufacturing workers report not wearing hearing protection. Additionally, 22-56% of noise-exposed Services workers report not wearing hearing protection, depending on sub-sector. (National Institute for Occupational Safety and Health, 2019).

Although implementation of engineering noise controls in industrial settings is an effective remedy and required by law, basic industrial noise control is not often taught to engineering students. This is especially true as the number of acoustics engineering students is declining and the number of those who specialize in industrial noise control is far less. It is, therefore, the authors' intent to promote inclusion of the most common, useful engineering noise control techniques to more engineering students. To that end the authors have developed the basics of a lesson focusing on engineering noise control fundamentals that adheres to ABET requirements for "public health, safety, and welfare," as well as ABET requirements for documenting student learning outcomes. The ultimate goal would be to promote the implementation of this lesson plan by professors teaching courses in general engineering or occupational safety engineering.

2 ABET ACCREDITATION OVERVIEW

The heart of ABET accreditation is the same as any standardization system in that ABET accreditation aims to promote consistency in quality and learning in engineering education programs. According to the ABET website, accreditation "assures confidence that a collegiate program has met standards essential to prepare graduates to enter critical STEM fields in the global workforce. (ABET, n.d.)" ABET accreditation is voluntary and currently 4,144 programs at 812 colleges and universities in 32 countries have received ABET accreditation (ABET, Accreditation, n.d.).

The process of becoming ABET accredited centers on the assessment process which focuses on identifying, collecting and documenting data related to student outcomes and program educational objectives. (ABET, Assessment Planning, n.d.). ABET emphasizes that assessment activities should be based on "learning outcomes" rather than 'teaching inputs," and should be part of an overall continuous quality improvement process (ABET, Why ABET Accreditation Matters, n.d.).

2.1 NOISE CONTROL ENGINEERING CONCEPTS THAT WOULD FIT INTO ABET ACCREDITATION

As is noted in the previous section, ABET stresses learning outcomes as the bases for its accreditation process. For 2020-2021 accreditation these outcomes are outlined in the document " Criteria for Accrediting Engineering Programs, 2020 – 2021 and highlights include the following (ABET, Criteria for Accrediting Engineering Programs, 2020 – 2021 , n.d.):

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- ***an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors***
- an ability to communicate effectively with a range of audiences
- an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Noticing that there are no particular student outcomes related to noise/vibration, it is not surprising that many engineering programs do not include fundamentals of noise control. Although, the science of noise and vibration are part of most fundamental physics classes, there is no requirement beyond that. Observe, however, that there is a requirement for student outcomes related to "public health, safety, and welfare" and that protecting populations like workers or the general public from the harmful effects of noise would fit into this student outcome. Also applying appropriate engineering noise control solutions would potentially meet other student outcomes like: solving complex engineering problems; grappling with ethical situations when health and safety can be in conflict with various project constraints; and collecting and interpreting data to solve problems.

Suggesting that solving problems involving noise as a safety and health concern, would therefore meet many of the required student outcomes. In the next section the basics of a lesson plan that meets many of the ABET-required student outcomes and includes learning objectives on engineering noise controls is presented.

3 SAMPLE LESSON PLAN

The following lesson plan is designed not only to include engineering noise control principles but also to meet several other ABET requirements. For instance, notice that the lesson plan:

- is structured around "learning outcomes" rather than 'teaching inputs" and documents these outcomes through pre- and post-tests
- is focused on engineering noise controls which demonstrate an "ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare"
- requires participants to consider the costs and feasibility of engineering solutions relative to their effectiveness
- is structured around teams which demonstrates an ability to function effectively as a team member
- requires participants to analyze and interpret data and use engineering judgment to draw conclusions, and

- calls on participants to acquire and apply new knowledge as needed, using appropriate learning strategies

3.1 LESSON PLAN ELEMENTS

The following are the basic components of a lesson plan that would meet ABET criteria. It is intended to provide enough structure to make implementation by the instructor convenient, but also allow enough flexibility to make adjustments.

Learning Objectives

The following are the suggested learning objectives for the lesson:

1. Remembering and understanding several of the most common and basic noise control techniques
2. Understanding and applying regulations and standards for protecting workers and the public from the harmful effects of noise
3. Analyzing various situations to suggest improvements based on noise control techniques
4. Evaluating the effectiveness of proposed noise controls based on effectiveness, practicality, ethics and compliance with regulations and standards

Pre- and Post-Tests

The students will take both a pre-test and post-test which will be the same and will aid in documenting the attainment of student learning objectives (a central feature of ABET accreditation). Relevant questions might include the following topics:

1. Recommended 8-hour time weighted average for noise
2. Distance required to lessen noise exposure by half
3. The relative advantages of moving noisy equipment away from walls, corners
4. Identification of the elements of various noise controls

Homework

As homework before the main lesson, the students will have to answer several simple questions to facilitate familiarity with the basic text. If a textbook does not contain information about basic noise control techniques, the following free document published by the World Health Organization (WHO) is a great resource and the basis of many textbooks on the subject https://www.who.int/occupational_health/publications/noise10.pdf (Hansen & Goelzer, 1996).

In-class Activity

The class should be separated into groups. Ideally the groups would have 3-5 members each and each group would be required to analyze a different case study about a noisy workplace. Each group would be required to identify and present to the class:

- A description of the situation and the main sources of workplace noise and other occupational hazards,
- A description of the best noise control techniques for that situation,
    - If calculations are necessary, those should be noted
    - Any particular best practices should be noted (for instance barrier material or other design considerations)
    - If several noise control techniques could be used, the group is to discuss why the one they chose is best

Discussion - Conclusions

After the group presentations, the instructor of the class will lead a discussion to facilitate deeper understanding about the process of industrial noise control which can include asking the following questions of the group:

1. What were common problems/solutions to the scenarios?
2. Which noise control techniques were most effective when they were practical?
3. Which noise control techniques would be hardest to implement?
4. Identify a situation where the noise control potentially costs a lot of money. For that situation is the company ethically or legally responsible for implementing the solution regardless of cost?
5. Now that the lesson is over, can anyone think of a noisy work situation that could be improved by applying any of these noise control techniques?

Post-Test and Possible Documentation of In-Class Activity

Classes and programs seeking ABET accreditation need to document the extent of student learning outcomes. This documentation can take the form of a post-test (same as pre-test) to show that students did gain knowledge as a result of the instruction. Additionally, it would be possible to assign each group the task of summarizing its in-class case study analysis in the form of a short report. All these materials would be kept for evidence of student learning outcomes for ABET accreditation purposes.

4 IDEAS FOR PROMOTING THE LESSON PLAN

If the objective of these activities is to promote familiarity and ability to implement engineering noise controls among all engineers, one of the biggest potential problems is that ABET accredited programs don't have to use this lesson plan or even include student outcomes related to noise control. It would be the authors' strategy to market this or similar lesson plans to ABET accredited organizations. Such a strategy would stress that the lesson plan: prepares students to use engineering problem solving skills on a common health and safety issue; documents the attainment of many ABET requirements; and is an interesting, interactive lesson for students.

Perhaps the best way to get the word out is to present the lesson plan at conferences centered on engineering education, like those endorsed by the American Society for Engineering Education (see https://www.asee.org/conferences-and-events/conferences/future-conferences) or conferences on teaching and learning (see http://crlt.umich.edu/publinks/natlconferences). Also, the Institute for Noise Control Engineering (INCE) has many members in academia who might choose to use this lesson plan in their noise control classes or other general engineering classes. These same professors might suggest that this lesson plan be part of colleagues' lessons or even offer to co-teach the lesson for general engineering classes. Lastly the implementation of this lesson might be documented and published in journals focusing on engineering education like the Journal of Engineering Education or the Journal of STEM Education.

5 CONCLUDING COMMENTS

As mentioned previously, occupational hearing loss is still a major issue in the United States. Promoting familiarity with common industrial noise control techniques and the ability to implement these techniques is a worthy goal. It is, therefore, the authors' objective to promote teaching the most common, useful techniques to more engineering students. Perhaps, if well-marketed, the lesson plan in this document might be implemented by more professors teaching courses in general engineering or occupational safety engineering classes.

This lesson plan has not yet been implemented. Although it was designed on well-proven techniques and concepts, it could be improved by implementation and evaluation. Developing and disseminating case-studies about the implementation of this lesson plan would also serve marketing goals via engineering education conferences or journals focused.

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