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Title: NIOSH Noise Control Project

Presenter: Edward Zechmann PhD, PE, INCE Bd. Cert.

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Overview

- Noise is a problem in construction
- Hierarchy of Controls
- Prevention through Design (PtD)
- Sell and Buy Quiet
- Life cycle scores



Photo Credit (NIOSH)

Hearing Loss is a Problem in Several Sectors

Burden

- 4.5 million construction workers exposed to hazardous noise
- 1 in 4 noise-exposed construction workers suffer Hearing Loss

Need

- Despite the earlier development of NIOSH's "Buy Quiet" campaign additional information is needed to support the routine purchase and use of quieter equipment

Impact

- A 90% reduction in noise exposure is possible for many types of power tools simply by replacing noisy equipment with quieter equipment.

Prevention through Design (PtD)

- Design out hazards to workers
- Redesign and retrofit new and existing equipment and work processes
- Prevent or reduce occupational injuries, illnesses, and fatalities
- Sell and Buy Quiet focusses on preventing noise exposure



Photo Credit (NIOSH)

Hierarchy of Controls

Most Effective



Least Effective

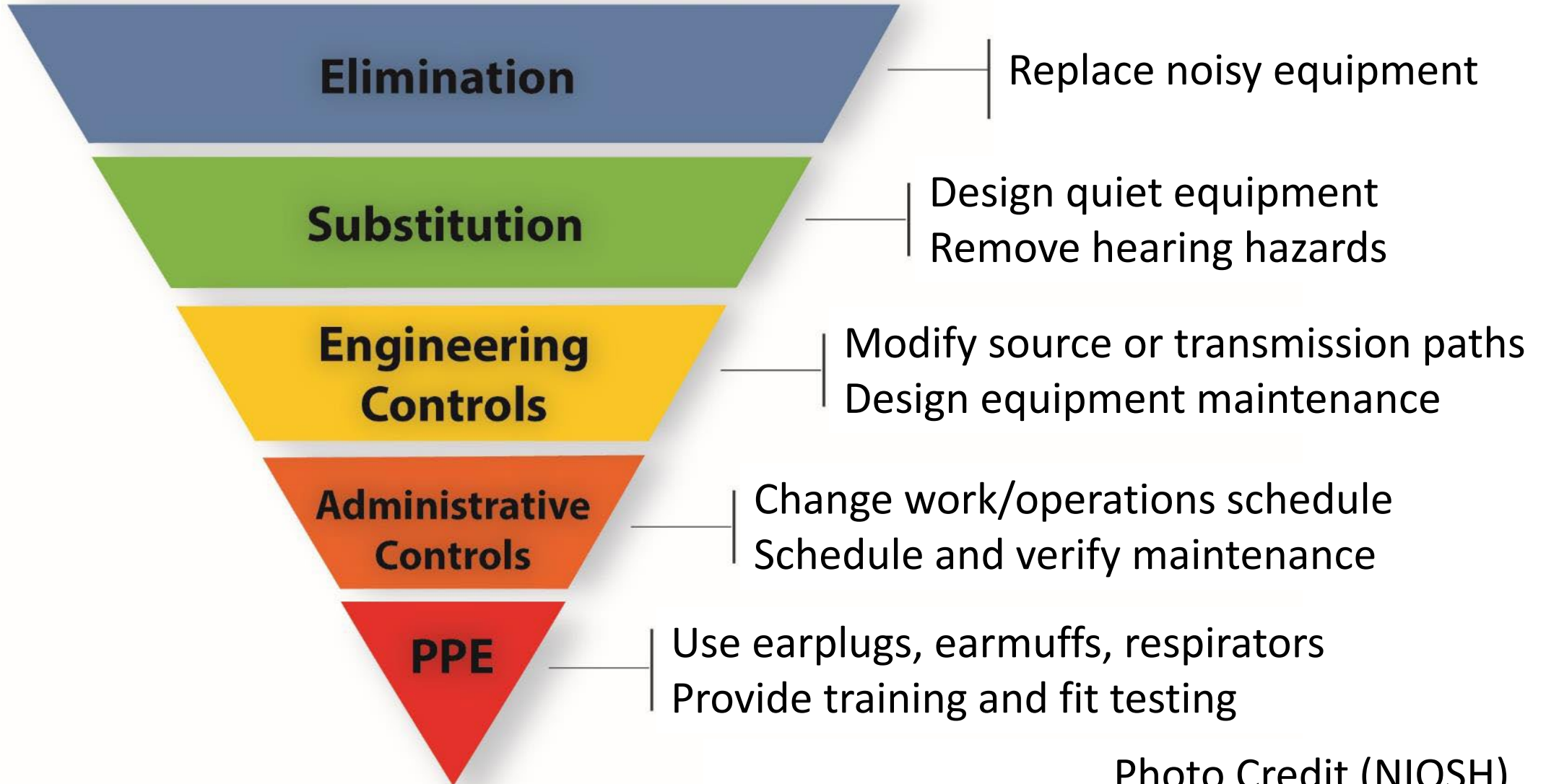


Photo Credit (NIOSH)

Sell and Buy Quiet

Replace the noisy tools with the quieter tools.

Make sure all the important factors are considered.

| Tool Type (Number of Tools) | Sound Power | | Average | Average |
|-----------------------------|-------------|-------|----------------|-----------|
| | L_{WA} | | Noise Exposure | Percent |
| | Max | Min | Reduction | Reduction |
| | dB(A) | dB(A) | dB(A) | % |
| Miter Saw (6) | 113 | 103 | 10 | 90 |
| Circular Saw (38) | 113 | 104 | 9 | 87 |
| Reciprocating Saw (23) | 112 | 102 | 10 | 90 |
| Impact Wrench (11) | 111 | 101 | 10 | 90 |
| Grinder (34) | 109 | 95 | 14 | 96 |

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Generalizing Sell and Buy Quiet is the solution!

- Hearing loss occurs and interacts simultaneously with many other factors
- All health, safety, and cost factors are considered
- SAE International Aerospace Standard AS6228
Safety Requirements for Procurement, Maintenance and Use of Hand-held Powered Tools
 1. Measure the factors
 2. Convert factors into subscores
 3. Choose importance weights from 0.5 to 2 for each factor
 4. Sum weighted subscores yielding total life cycle scores
 5. Sort the power tools models by descending life cycle score

SAE AS6228 Safety Procurement Standard

- Focus on making safer, healthier, more cost-effective power tools available in the Federal supply system.
- Optimize supply management addressing noise, hand-arm vibration, physical safety, ergonomics, and other factors
- Engage safety and health professionals in procurement decisions
- Adapt procurement process for eCommerce by sorting products based on the life cycle score.
- Power tools had a \$42.8 billion global market in 2022

SAE AS6228 Safety Procurement Standard

| Measured Factors | Weight (0.5 - 2) | Subscore (1-10) | Weighted Subscore |
|------------------------------|---------------------|--------------------|----------------------|
| Productivity | 2 | 5 | 10 |
| Ergonomics | 2 | 7 | 14 |
| Noise L_{WA} | 1 | 6 | 6 |
| Hand-arm vibration a_{rms} | 2 | 7 | 14 |
| Initial Purchase Cost | 0.5 | 1 | 0.5 |
| Operating cost | 1 | 5 | 5 |
| Utility Cost | 0.5 | 5 | 2.5 |
| User Acceptance | 1.5 | 8 | 12 |
| Life Cycle Score | | | 64 |

Subscores: 1 is low 10 is high

Weight \times Subscore = Weighted Subscore

Table is adapted from Zechmann 2018

Higher Life Cycle Scores are better

Overview of Life Cycle Scores

- 1) Identify the tool type for the task to be completed
- 2) Research the current state of the technology for the tool
List the important factors to consider when making a purchase
- 3) Research reputable manufacturers that produce the tool
List promising models of tools for data collection
- 4) Use the life cycle formula to calculate the life cycle score for each model
- 5) List the tools by descending life cycle score and select a high-scoring tool
to best complete the identified task in the safest manner possible

107 dBA

Photo Credit (NIOSH)



108
dBA



110
dBA



Life Cycle Score - Step 1

Identify the tool for the task to be completed

- Identify tasks that need to be completed by an individual piece of equipment.
- Identify the type of equipment that will complete the tasks.
- Develop a theme such as “Best affordable angular grip Battery powered leaf blower” to help refine the search.

Photo Credit (NIOSH)



Life Cycle Score - Step 2

Research the current state of technology

- Perform a technical information search on the type of equipment to understand the current state of the technology available.
- Global Spec and How Stuff Works are examples of technical information websites.
- Use the technical information search to identify the important factors to consider when making a purchase.
- Make a list of the most important factors to consider.

93 dBA

Photo Credit (NIOSH)



Life Cycle Score - Step 3

Research reputable manufacturers

- Do a search to identify the manufacturers. Make a list of reputable manufacturers. Do a search to identify search engines, shopping search engines, and shopping websites. Make a list of those internet resources that include the important factor information.
- Use a search engine to find manufacturers. There are websites that have lists of manufacturers.
- There are business review websites which may be helpful for assessing manufacturers, sellers, and other companies in the business chain.

Life Cycle Score - Step 4

Use the life cycle formula to calculate

- Make a spreadsheet which has the important factors in the columns and has power tools the rows.
- Fill the spreadsheet with the factor data.
- Use piecewise linear, logarithmic, and exponential scaling formulae to convert the measured factors to subscores from 1 to 10.
- Identify the weighting for each factor from 0.5 to 2 based on relative importance of the factors.
- Sum the products of the weights and subscores to produce the total life cycle scores.

Life Cycle Score - Step 5

- Sort the list power tools by descending life cycle score.
- Choose a power tool that is close to the top of the indexed product

| Impact Wrench Mask Number | Energy System | Reverse Torque Nm | L_w dBA | L_p dBA | a_{rms} m/s ² | Cost USD |
|------------------------------|------------------|----------------------|--------------|--------------|-------------------------------|-------------|
| 1 | Battery | 1491 | 100 | 89 | 12.2 | 433 |
| 2 | Pneumatic | 1760 | 103 | 92 | 7.7 | 405 |
| 3 | Pneumatic | 1760 | 103 | 92 | 9.0 | 340 |
| 4 | Pneumatic | 1302 | 105 | 94 | 12.0 | 214 |
| 5 | Pneumatic | 610 | 106 | 95 | 12.1 | 187 |
| 6 | Battery | 2040 | 106 | 95 | 17.0 | 476 |
| 7 | Battery | 2040 | 106 | 95 | 17.0 | 568 |
| 8 | Pneumatic | 1356 | 107 | 96 | 8.7 | 525 |
| 9 | Pneumatic | 1100 | 108 | 97 | 9.6 | 243 |
| 10 | Pneumatic | 678 | 109 | 98 | 16.0 | 79 |

Jack Hammers – Testing

Test Setup



No Controls



All Controls



Jack Hammers - Noise Control Data

- Available noise control solutions
 - ✓ Quiet jack hammer with built in mufflers
 - ✓ Weighted jacket that covers the bottom
 - ✓ Lead jacket over the top
 - ✓ Constrained layer damped chisel
- Preliminary data shown below

| | No Controls | All controls | Noise Reduction |
|-------------------------|--------------|--------------|-----------------|
| Jack Hammer Mask Number | L_w dBA | L_w dBA | dBA |
| 1 | 117 | 108 | 9 |
| 2 | 114 | 113 | 1 |
| 3 | 115 | 111 | 3 |
| 4 | 119 | 116 | 3 |

Framing Nailers - Lack of Noise Data

EN 12549:1999 is the standard for measuring fastener tool noise

Lack of manufacturer data

- Sound power data was NOT found on US manufacturers websites or manuals.
- Sound power data was found on European manufacturers websites and manuals.

Problems

- A-weighted sound power does not fit the hearing loss model sufficiently well for impulsive noise
- Sound power is confused with output power and input power
- Not intuitive requires some education

Future Work

- Further develop noise controls for Jack Hammers
- Publish Life Cycle Scores on Impact Wrenches, Leaf Blowers, and Light Towers
- Estimate the Life Cycle Scores for Framing Nailers
- Develop a better noise metric for impulsive noise
- Publish a Blog on “Sell and Buy Quiet”
- Publish a Blog on “Life Cycle Scores”
- Publish a journal article on calculating Life Cycle Scores

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Questions

- Noise Controls
- Prevention Through Design (PtD)
- Sell and Buy Quiet
- Life Cycle Scores - SAE AS6228

- Edward Zechmann
- cri6@cdc.gov
- 513-533-8115