Communication & Safety in the Arboricultural Workplace:
Four things every owner and employee must know to avoid human factor errors

November 2013
“Human factor errors are mistakes in judgment that lead to accidents and injuries. Of all the human factor errors, lack of communication is the number one mistake.”

**Executive summary**

Research suggests that as much as 80 percent of all workplace accidents are due to “human factor errors” — mistakes in judgment and perception that lead to injury. Human factor errors come in many forms, ranging from fatigue and stress to distraction and complacency. But on this point most researchers agree: lack of communication is the single biggest human error and a contributing factor to almost all occupational accidents.

Arboriculture shares a similar risk profile to that of logging — generally regarded as one of the 10 most dangerous job in the United States. Loggers and arboriculturists use similar equipment, and both face threats from dangerous machinery, heavy falling objects, and constant exposure to hazardous levels of noise.

Much attention has been paid to the need for hearing protection in the arboricultural workplace, but conventional forms of personal protective equipment, such as earmuffs, carry with them an entirely different set of risks. Earmuffs protect against the potentially damaging effects of noisy equipment, but they also make it difficult for workers to communicate with each other. And in an environment where a real-time verbal warning can spell the difference between life and death, any delay in communication can have tragic consequences.

This white paper presents a simple, four-point framework for understanding and avoiding human factor errors on the job:

1. Most accidents are due to human error, not faulty equipment or other external factors.
2. Lack of communication is the single biggest cause of human error.
3. Hearing protection alone is insufficient to create a safe working environment.
4. Enabling clear, continuous, and hands-free communication is the most important step you can take to ensure a safe workplace.

After showing how this framework applies to arboriculture, we explore how wireless communication headsets fulfill these requirements and conclude with a buyer’s guide for those considering purchase of a system.
Clear communication is essential for creating a safe and productive workplace. This is especially true in the arboricultural industry, where work crews not only struggle to hear and be heard over noisy machinery, but must contend with a wide variety of hazards, including exposure to overhead power lines, falling branches and tools, and faulty safety equipment. In these situations, a missed or misunderstood warning can have serious or even fatal consequences.

Arboriculture shares a similar hazard profile to that of logging, which is generally regarded as the second most dangerous occupation in the United States. Loggers and arboriculturists use similar equipment, and both face threats from dangerous machinery and heavy falling objects. A 2009 study by the North Carolina Department of Labor found a nearly complete overlap between the most common health and safety citations issued for logging and those issued for arboriculture, particularly for failure to employ appropriate personal protective equipment.

Safety specialist Gordon Dupont has devoted his career to investigating the root causes of accidents in the workplace. His famed “Dirty Dozen” list of human factor errors have been adopted as a model for occupational safety and health in industries ranging from aircraft maintenance to medicine. “Human factor errors” are mistakes in judgment and perception that, while unintentional, lead to accidents and injuries. Of the 12 human factor errors that Dupont cites, “lack of communication” is the number one mistake that causes accidents. Interruptions in communication can

---

cause orders to be misinterpreted, improperly carried out, or completely missed. Simply put, if crew members do not — or cannot — exchange information, the stage is set for an accident to occur.

Arboricultural operations present a difficult problem: how to protect workers from noise-induced hearing loss while still allowing them to hear each other. In the past, tree care professionals have had few choices for communicating on the job and even fewer choices for hearing protection. Earplugs protect hearing, but make it even harder to communicate. Communication typically takes place by shouting, hand signals, or walkie-talkies. Each of these “solutions” has serious drawbacks. Shouting can cause dangerous misunderstandings. Hand signals require line-of-sight visibility, can easily be misinterpreted, and are virtually useless at night or during inclement weather. Walkie-talkies enable direct communication, but do nothing to protect hearing, and also require a free hand for operation. As a result, communication during arboricultural operations is often unreliable, haphazard, and ambiguous.

Arboriculture and landscaping:
Noisier and more dangerous than you think

Although arboriculture is not necessarily the “noisiest” occupation, tree care professionals are exposed to dangerous levels of noise every day and thus face a constant risk of noise-induced hearing loss. The National Institute for Occupational Safety and Health estimates that approximately 30 million American workers are exposed to hazardous levels of noise on the job. According to a recent study by the Better Hearing Institute, people with untreated hearing loss lose as much as $30,000 in income annually – or approximately $176 billion overall.

The International Society of Arboriculture has adopted consensus standards for safety, compiled in ANSI Standard Z133-2012. These standards provide, among other things, that those engaged in arboricultural operations should wear appropriate hearing protection when the time-weighted noise exposure equals or exceeds 85 dB(A) in an 8-hour period.

---

6 The other factors are: complacency, lack of knowledge, distraction, lack of teamwork, fatigue, lack of resources, pressure, lack of assertiveness, stress, lack of awareness, and norms.


9 Available from the International Society of Arboriculture, PO. Box 3129, Champaign, IL 61826-3129, www.isa-arbor.com
This recommendation has also been adopted by the Occupational Safety and Health Administration as a requirement in the workplace. As shown in Table 1, the equipment used in the arboricultural and landscaping environment routinely exceeds that level; hence, the need for hearing protection.

It is important to note that the decibel scale is logarithmic, ranging from 0 (lowest detectable sound) to 194 (loudest theoretically possible sound). Each increase of 10 decibels doubles the perceived volume of sound. Thus, an increase of 20 decibels will sound four times as loud; an increase of 30 decibels will sound eight times as loud, and so on. To put the scale into perspective, a ticking watch emits 20 decibels; normal conversation takes place at around 65 decibels; a passing motorcycle emits 100 decibels; a rock concert averages 120 decibels; and a gun blast from 100 feet away emits 140 decibels. The human pain threshold is typically around 110 decibels and sounds above 150 decibels (such as a jet engine) can puncture the eardrum. Most listeners can detect a substantial difference of even one decibel.

### Table 1: Noise Levels in Arboriculture and Landscaping

<table>
<thead>
<tr>
<th>Equipment/activity</th>
<th>Average dB level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notching stumps</td>
<td>83</td>
</tr>
<tr>
<td>Backhoe</td>
<td>89</td>
</tr>
<tr>
<td>Truck, 20 ton</td>
<td>92</td>
</tr>
<tr>
<td>Air compressor</td>
<td>95</td>
</tr>
<tr>
<td>Tree felling</td>
<td>98</td>
</tr>
<tr>
<td>Wood chipper</td>
<td>99</td>
</tr>
<tr>
<td>Lawnmower</td>
<td>99</td>
</tr>
<tr>
<td>Mobile crane</td>
<td>99</td>
</tr>
<tr>
<td>Bedding chopper</td>
<td>102</td>
</tr>
<tr>
<td>Chain saw</td>
<td>110</td>
</tr>
</tbody>
</table>

Four things every employer and employee must know to avoid human factor errors

Whether you are an employer or an employee, the responsibility for maintaining a safe and productive work environment is everyone’s business. Research shows the following four elements are crucial to achieving that goal.

- **Most accidents are due to human error, not faulty equipment or other external factors.** While equipment failure can certainly contribute to accidents, research in occupational safety suggests that as much as 80 percent of all accidents are due to human error.

- **Lack of communication is the single biggest cause of human error.** Interruptions in communication can cause orders to be misinterpreted, improperly carried out, or completely missed. Simply put, if crew members do not — or cannot — exchange information, the stage is set for an accident to occur.

---


• **Hearing protection alone is insufficient to create a safe working environment.** Ironically, while conventional forms of hearing protection may prevent noise-induced hearing loss, they actually make it *more* difficult for crew members to communicate with each other. Passive forms of hearing protection, such as earplugs or earmuffs, can reduce situational awareness and prevent crew members from hearing a warning or a critical instruction. A safe work environment can only be achieved if workers can communicate *without* having to remove their personal protective equipment.

• **Enabling clear, continuous, and hands-free communication is the most important step you can take to ensure a safe workplace.** Inherently dangerous jobs, such as arboriculture, require that workers be able to communicate as easily as if they were in an office or talking on the telephone. To maintain a safe working environment, verbal warnings must be delivered in real time and instructions must be understood by all during the performance of shared tasks.

**Wireless communication headsets**
Recent advancements in technology provide a solution to the human factors problem in the form of portable wireless headset systems (Figure 1). Wireless headsets reduce background noise and allow work crews to communicate clearly, even on opposite sides of a work site. Headsets fit completely over the ear for hearing protection and are outfitted with a boom microphone and ear speakers to allow hands-free voice transmission and reception through a mobile base station using a wireless signal. In more advanced systems, the local audio network itself can be connected to a two-way radio, allowing communication with remote users, such as headquarters or crews working at other locations.

Wireless communication headsets are rapidly becoming the best practice for simultaneously protecting hearing and enabling communication in high-noise environments. Headsets can reduce ambient noise exposure by 20 to 30 decibels, ensuring voice transmissions can be heard clearly and allowing teams of almost any size to communicate easily. Simply stated, **wireless headsets ensure all members of a work team can hear and be heard.** Properly designed and configured, they also leave the wearer’s hands free and allow unrestricted movement around the worksite.

“Hearing protection alone is insufficient to create a safe work environment. A safe work environment can only be achieved if workers can communicate *without* having to remove their personal protective equipment.”
“Simply stated, wireless headsets ensure all members of a work team can hear and be heard.”

Buyer’s guide to wireless headset systems

Wireless headset systems are available in a wide variety of configurations and price ranges. To ensure a particular system meets your needs, consider the following factors carefully.

- **Is the system truly wireless?** A number of so-called “wireless” systems actually require a wire from the headset to a radio or belt pack, creating many of the same problems inherent in hardwired systems, particularly tangled cords. Moreover, belt packs generally have less transmission range than systems worn on the head.

- **How knowledgeable is the dealer and what kind of training and support does he or she receive from the manufacturer?** The dealer from whom you purchase your system is a critical link in ensuring you receive support after the sale and that the final solution meets your needs. Look at the dealer’s longevity and reputation in the industry and do not hesitate to ask for references.

- **Is the system DECT or Bluetooth?** DECT technology offers up to 30 times the coverage area of Bluetooth and is less subject to interference in the 30MHz - 1.8GHz spectrum. Systems that employ Bluetooth have a limited range and are subject to interference from nearby communication devices, especially those operating on the 2.4 GHz or 5 GHz channels. DECT transmissions also have multipath capability, meaning that the signal will bounce up, over, and around objects in order to establish the best possible connection. For enhanced security, DECT signals are digitally encoded to ensure privacy.

- **Is the system full-duplex or half-duplex?** Half-duplex systems allow communication in both directions, but only one direction at a time, similar to a walkie-talkie. Once a party begins transmitting, all other transmissions are “locked out” until the first transmission is over. Full-duplex systems allow communication in both directions simultaneously, similar to a telephone call. Full-duplex capability is an important safety consideration because it allows the parties to speak and hear others at the same time.

- **Is the system radio-compatible?** Wireless systems should have the capability of interfacing with mobile radios to allow communication with remote users. Given the large number of radio makes and models available, look for a system with maximum interface flexibility.
• Can the duplex capabilities be configured to your specific needs? To minimize the chance of “cross-talk,” or multiple conversations taking place simultaneously, the system should allow you to establish a hierarchy of who can talk to whom — especially who is allowed to broadcast over the radio.

• Is the system scalable? As your needs expand, your wireless system should be able to expand with you. Systems should accommodate up to 60 users.

• Is the system comfortable to wear and easy to use? Before purchasing, physically try on a headset. It should be lightweight and fit snugly, but comfortably, over the ears. If you are purchasing hard hat-compatible headsets, try one on while actually wearing a hard hat to ensure a comfortable fit. The controls should be readily accessible, preferably with a simple push-to-talk button or toggle-to-talk switch for accessing the radio.

• What is the system’s Ingress Protection Rating? The Ingress Protection Rating (IP), is an international standard that rates the degree of protection against the intrusion of solids and liquids into an electrical unit. A wireless headset should have a minimum rating of IP65 when worn. This indicates that the unit is completely impervious to dust and is capable of withstanding a stream of water for three minutes without damage to the interior components.

• What is the range of the system? The greater the range, the more effective the system will be for your application, since obstacles and vehicles may reduce range. Look for a minimum 1500-foot line-of-sight transmission capability, bearing in mind that system performance may deteriorate at the outer limits of the range.

• What is the Noise Reduction Rating? Noise Reduction Rating (NRR) is the measurement, in decibels, of how well a hearing protector reduces noise. While wearing hearing protection, your exposure to noise is equal to the total noise level minus the NRR of the hearing protectors. If you were exposed to 95 decibels of noise but were wearing a headset with an NRR of 20, your actual noise exposure would be 75 decibels. Look for an NRR of at least 22.
“Not all wireless headset systems are equally reliable and durable over the long term. Make sure the system is designed for use in your operating environment, and ask about warranty, repair, and replacement policies.”

- **What is the operating temperature range?** Extreme temperatures can affect battery life and headset operation. Look for an operating range of at least -30 to 140 degrees Fahrenheit.

- **Are all components necessary for operation included in the purchase price?** The price you pay should deliver a complete system that is ready for operation. Accessories such as battery chargers and charging cables should be included, not “added on” as options.

- **What about warranty and service?** Not all wireless headset systems are equally reliable and durable over the long term. Make sure the system is designed for use in your operating environment, ask about warranty, repair, and replacement policies, and try out the manufacturer’s technical support prior to making a decision. A two-year limited warranty is standard in the industry and some vendors provide extended plans of up to five years.

Wireless headset systems are a safe and convenient method of ensuring clear communication among arboricultural professionals. Clear communication is an essential element in every team’s effectiveness and productivity.

It could even save a life.

Sonetics Corporation offers a complete line of team communication solutions for arboricultural and other challenging environments. To learn more, visit: www.soneticscorp.com, e-mail sales@soneticscorp.com, or call 800.833.4558.
## SIDE-BY-SIDE COMPARISON

When shopping for a wireless headset system, you may find it useful to compare the features and functionality of each system under review. The following chart may be helpful in comparing features at a glance.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sonetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truly wireless?</td>
<td>Yes; a belt pack or radio wire is not necessary</td>
</tr>
<tr>
<td>Range</td>
<td>1600 feet line-of-sight</td>
</tr>
<tr>
<td>DECT or Bluetooth?</td>
<td>DECT</td>
</tr>
<tr>
<td>Full- or half-duplex?</td>
<td>Full-duplex</td>
</tr>
<tr>
<td>Configurable duplex?</td>
<td>Yes, with a variety of push-and toggle-to-talk options</td>
</tr>
<tr>
<td>Noise Reduction Rating</td>
<td>26</td>
</tr>
<tr>
<td>Radio-compatible?</td>
<td>Yes, with over 400 models</td>
</tr>
<tr>
<td>Maximum users</td>
<td>60</td>
</tr>
<tr>
<td>Secure communication?</td>
<td>Yes; digital and fully encrypted</td>
</tr>
<tr>
<td>Comfortable headsets?</td>
<td>ComLeather and closed cell foam ear seals for comfort</td>
</tr>
<tr>
<td>Ingress Protection Rating</td>
<td>IP65</td>
</tr>
<tr>
<td>Knowledgeable dealer?</td>
<td>Dealers extensively trained to act as problem-solvers</td>
</tr>
<tr>
<td>Battery life</td>
<td>24 hours of operation on a two-hour charge</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40° to +158° F</td>
</tr>
<tr>
<td>Microphone</td>
<td>Noise-canceling electret</td>
</tr>
<tr>
<td>Battery charger and heavy-duty automotive charging cable</td>
<td>Included</td>
</tr>
<tr>
<td>Warranty</td>
<td>Two year standard; expandable to five years</td>
</tr>
</tbody>
</table>
Sonetics Corporation offers a complete line of team communication solutions for arboricultural, landscaping, and other challenging environments