DEVELOPING EFFECTIVE WARNINGS FOR THE WORKPLACE

After all hazards have been identified, analyzed, and prioritized, warning prototypes can be designed.

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Each year, millions of people are injured in the workplace. One of the most difficult tasks facing employers is to identify the hazards associated with the products and equipment used by their employees. Such careful considerations will not only provide a safe work environment for the employee, but protect the employer as well, in that costs associated with workplace injuries (loss of productivity, worker's compensation) and litigation will be minimized.

If hazards are present in the workplace, steps should be taken to change the work environment to remove or minimize them. First and foremost, attempts should be made to design the hazard out of the jobs, equipment, tools, and environment. Of course, alternatives are not always available or practical to eliminate all hazards.

A basic method of reducing hazards is to use guards that prevent the employee from coming into contact with the hazard. Guarding can be accomplished physically (barriers) or procedurally (e.g., requiring certain behaviors before working with equipment or tools). When a hazard cannot be eliminated or adequately guarded against, then, as a third step, employees should be warned about the hazard. Employers should take steps to ascertain that warnings are designed to maximize the likelihood the employees will notice, understand, and comply with them.

Guidelines for the design of effective warnings have been developed from research and standards (ANSI Z535, 2002). We describe these in the remainder of this article.

Too often, warnings are designed and implemented without being tested.

Warnings Development Paradigm

The warning development paradigm consists of four phases: (1) planning, (2) analysis, (3) design, and (4) evaluation.

Planning

Successful warning development depends on thorough planning prior to development and testing. The objective of this phase is to identify the focus of the warning, the amount of time to create the warning, and available resources. Planning also entails determining the characteristics of the employee. These include:

- Reading level
- General public vs. members of a specialized field
- Native vs. non-native English speakers/readers, and
- Sensory modality impairment (hearing, vision, etc.).

These characteristics will help shape the warning's design so it effectively communicates the intended message. The average reading level of the employee needs to be considered, to prevent using language that is not understandable. Another consideration is whether a large percentage of the population is non-native English users. If so, the warning may need dual-language presentation. Finally, potential sensory modality impairments (poor vision or hearing) of the employees should be considered. The use of personal protective equipment (hearing protection, welding visors, etc.) may lessen the ability of people to hear or see. If such devices are used, consider their effect (e.g., use louder warnings or higher visual contrast).

Who will be involved in the warnings development process is an important consideration. Some experience in engineering, product design, marketing, and litigation is desirable. Company employees may not have the knowledge or experience to design effective warnings, so it may be necessary to hire a consultant who specializes in warnings and risk communication to facilitate the development process, especially with respect to testing methods.

Analysis

The analysis phase consists of the following steps: (1) task analysis, (2) identifying the hazards, (3) risk evaluation, and (4) hazard prioritization. If possible, investigate how employees will use the product and at what points during product use the warning might be needed. This can best be accomplished through task analysis.

Task or job analysis decomposes a task or job a person must perform into its basic components. Once a task analysis has been conducted, the potential hazards of the product must be identified and evaluated to determine the amount of risk they pose.

Finally, hazards should be prioritized so the main hazard receives greater attention than those that would likely pose minimal danger.

Design

After all hazards have been identified, analyzed, and prioritized, warning prototypes can be designed. The hazards prioritized in the analysis phase will guide which messages should be included in the warning. Each message should include (1) an explanation of the hazard, (2) consequences if precautionary behavior is not taken, and (3) what can be done to protect yourself from the hazard.

Once the aforementioned steps have been completed, the format and design characteristics of the warning should be defined. A start for any warning designer is adherence to the American National Standards Institute's Z535. This standard, revised in 2002, provides guidelines for the development of warning signs and labels.

As illustrated in Figure 1, the sign consists of three main components: signal word panel, symbol panel (optional), and message panel. It should be noted that through 2002, ANSI allowed the use of OSHA-compliant warnings (see Figure 1), but this is no longer the case. Because OSHA adopted a precursor to the current ANSI Z535 standard (the precursor is ANSI Z535.1-1967), employers who comply with the updated ANSI standard will not result in an OSHA violation under OSHA's de minimis policy.

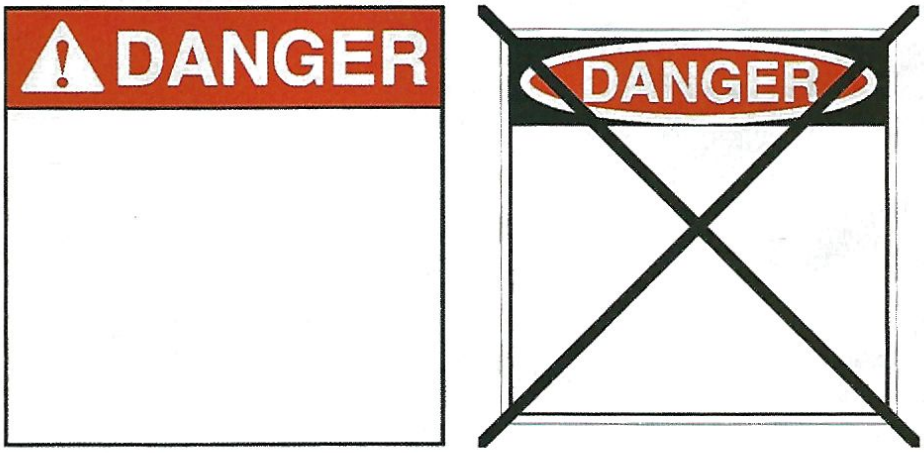

Figure 1. ANSI Z535.4 Compliant (left) and Non-compliant (right) Warnings

Sign/Label Format

- Signal words: ANSI Z535 recommends the use of *Danger, Warning,* and *Caution* to convey decreasing levels of hazard. Signal words conveying greater hazards will be more effective. As Figure 1 illustrates, the signal word appears in the signal word panel at the top of the sign/label.
- Color: The signal word panel background/foreground text color usage recommended by ANSI are red print on a white panel background, black print on an orange background, and black print on a yellow background to convey decreasing levels of hazard for DANGER, WARNING, and CAUTION, respectively. In Figure 1, the signal word DANGER is printed in white on a red background to convey the greatest hazard, according to the ANSI Z535 standard.

While the ANSI standards are guidelines to facilitate the development of effective warnings, it is important to note that government regulations (e.g., OSHA's 1910.145, etc.), which require adherence by law, also must be considered. Although adherence to ANSI Z535 standards and technical regulations is important, other features should be considered in designing warning signs and labels. An effective warning should accomplish three interrelated goals: (1) capture attention; (2) be understood; and (3) increase compliance.

In order to capture attention, warnings must have greater conspicuity than the context in which they appear. This is particularly important in a work environment in which there may be numerous activities and distractions that compete for the employees' attention. Once the receiver's attention is captured, he or she must comply with the warning for it to be effective. An individual's motivation to comply with a warning's directives is often affected by expectations concerning the level of hazard associated with a job or environment.

The following section presents guidelines for warning development. Some are addressed by the ANSI standard, and others are based on research findings. These guidelines address both conspicuity and compliance issues.

Guidelines for Warnings Development

Format

- Warning must be large enough to be seen by the intended audience.
- Left-justify the text.
- Orient messages to read from left to right.
- Place the most important warning statements at the top.

Wording

- Use as little text as necessary to clearly convey the message.
- Use short sentences rather than long, complicated ones.
- Be explicit—tell the reader exactly what to do or not do.
- Use short, familiar words. Avoid technical terms and jargon.
- Avoid using abbreviations unless they have been tested on the user population.
- Use bulleted lists to communicate points or steps.
- Use the active voice rather than passive voice.
- Use concrete rather than abstract wording.
- Avoid using words or statements that might have multiple interpretations.

Signal Words

- Danger—Indicates immediately hazardous situation that will result in death or serious injury if not avoided; use only in extreme situations.
- Warning—Indicates a potentially hazardous situation that may result in death or serious injury if not avoided.
- Caution—Indicates a potentially hazardous situation that may result in minor or moderate injury.

Pictorials

- Use only symbols that have been comprehension-tested (refer to the following section on evaluation for a more detailed description).

Font

- Use mixed case letters. Avoid using all capitals except for signal words.
- Use san serif fonts (Arial, Helvetica, etc.) and larger font size for signal words.
- Use serif fonts (Times, Times New Roman, etc.) and smaller font size for warning messages.
- Print in a font size large enough so it is readable at a distance and by older people.

Color

- A red panel should be used with the signal word "Danger."
- An orange panel should be used with

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signal word "Warning."
- A yellow panel should be used with the signal word "Caution."
- An alert or signal icon (triangle surrounding an exclamation point) should be included in these panels when human injury is a concern.

Evaluation: Testing is Needed to Be Sure

The final step in the design phase is to develop prototypes of warnings, which then should be evaluated to identify which one will be used as the final design. All too often, warnings are designed and implemented without being tested. There are two major types of testing: comprehension and behavioral.

Comprehension testing should be conducted on both textual and pictorial (if included) components. Such testing focuses on whether receivers understand the information being conveyed by a warning. With respect to pictorials, two sets of guidelines are used to guide comprehension testing: ANSI 1998b and the International Organization for Standardization (ISO, 1988). The former requires that 85 percent of individuals will comprehend the meaning of the given pictorial with less than 5 percent critical confusions (understanding the pictorial to mean opposite of its intended message). ISO, on the other hand, requires a 67 percent comprehension rate.

Most often, behavioral testing examines behavioral intentions rather than actual behavioral compliance. *Behavioral intentions* are reported actions a person will take when exposed to a warning, which are typically measured by a questionnaire. *Behavioral compliance* consists of observing a person interacting with a warning, to determine whether the actions are in accordance with the warning message. Behavioral compliance can provide the most valuable information, but it is often time-intensive and costly.

After conducting the evaluations, the warning prototypes probably will have to be modified because the warning design process is iterative by nature. The necessary changes will be guided by the feedback received during the usability inspections and testing. After the necessary changes have been made, the new prototype should be re-tested. This process should be repeated until the warning is deemed acceptable.

Conclusions

Designing effective warnings requires careful planning and familiarity with basic warning design guidelines and principles. As noted above, testing is a critical step in the design process. Appropriately implementing and following the warning design process presented in this article increases the likelihood an effective warning will be developed, and hence, fosters safety in the workplace and reduces work-related injuries. ■

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