Warnings 101

Richard E. Forbes, Ph.D., P.E. and Mary C. Emplaincourt, M.S., M.A.
Mississippi State University

Abstract

It is accepted practice for designers to "design out" dangerous machine elements when this can be done without significantly affecting utility or cost of the device. Often this is not possible; for example, a hand-held circular saw must be sharp and rotate at high speed to perform its intended function. If the danger cannot be removed by design, the designer incurs an obligation to devise an effective guard, if possible. There exist in some cases (i.e., the hand-held circular saw) specific design conditions that the guard must satisfy. When neither design nor guarding will remove the danger, proper accident prevention signs (warnings) must be utilized and located at appropriate locations on the device.

Although accident prevention signs were standardized as early as 1941, and the guidelines have remained relatively unchanged, signs written today often do not conform to these standards. Accident prevention signs, if they are to be effective, must alert the observer to the level of the hazard and should always be presented in the prescribed format. This paper presents a historical survey of accident prevention signs as presented in standards published by the United States of America Standards Institute (later to become the American National Standards Institute, ANSI), Occupational Safety and Health Administration (OSHA), the Society of Automotive Engineers (SAE) and other standards publishing agencies.

Introduction

Both the American National Standards Institute (ANSI) and the Occupational Safety and Health Administration (OSHA), publish standards that should be followed when selecting or designing accident prevention signs. For example, specific color format and general configuration are prescribed for "Caution," "Warning," and "Danger" signs. Both standards also indicate that each of the "signal words" (Caution, Warning, Danger) should be chosen to reflect the level of the unsafe condition.

A common occurrence is the observation of accident prevention signs that do not conform to the general guidelines of either ANSI or OSHA. This paper will discuss the requirements for proper accident prevention sign design (using ANSI, OSHA, and other available standards) and will present various examples of conforming and non-conforming signs. The information should be useful to anyone who has a job function that includes designing, selecting, and using accident prevention signs in their workplace.

Historical View of Accident Prevention Signs

In 1941, the American Standards Association, under sponsorship of the National Safety Council, published ASA Standard Z35.1-1941 titled Specifications for Industrial Accident Prevention Signs. The forward to this standard states:

"Design, application and use of warning signs or symbols (other than slogans) intended to indicate, and insofar as possible, to define specific hazards of a nature such that failure to so designate them may cause, or tend to cause, accidental injury to workers, or the public, or both."

The standard recognizes the need for uniformity in accident prevention signs and recommendations that Danger, Caution, Safety Instruction, Directional, and Information be the categories for signs. Sign purposes were listed as:

Danger	to warn of specific dangers only,
Caution	to warn of possible dangers or unsafe practices,
Safety Instruction	to provide information relating to general safe practices,
Directional	to indicate the way to stairways, fire escapes, exits, and other locations, and
Information Signs	to carry messages of general nature, such as rules, regulations, and markers when such postings do not conflict with Danger or Caution purposes.

Sign Colors were indicated as:

Danger	White background with word DANGER shall appear in WHITE letters on a RED oval. The red oval should be placed inside a BLACK rectangular panel with a WHITE line separating the outside edge of the red oval from the adjacent edge of the black panel.
Caution	YELLOW background covering the face of the sign. The word CAUTION shall appear in YELLOW letters on a black rectangular panel.
Safety Instruction	Should have a white background. Words should be in white letters on a green rectangular panel.
Directional	Should have a white background. Arrows should be in white on a black rectangular panel. Wording should be in black. Does not apply for building EXIT signs.
Information	May be in any of a variety of designs and colors, except that neither red nor yellow shall be used.

FIG. 1. Standardized Form for DANGER Signs Specified in ASA Z35.1-1941.

On Figure 1, note the red oval is the major feature of this sign and should only be used where specific known dangers exist. Standard colors are red, white, and black.

FIG. 2. Standardized Form for CAUTION Signs Specified in ASA Z35.1-1941.

On Figure 2, note that the specified colors are yellow and black, and the sign should be used in applications to warn of possible dangers or unsafe practices.

The information embodied in this standard has seen no significant alteration since its publications over 50 years ago. Danger and Caution signs are still used to indicate the level of hazard expressed in ASA Z35.1-1941 and the required colors are still those presented in 1941. Note that the word "shall" indicating, "is to be understood as mandatory" is used when prescribing the color format for both Danger and Caution signs. The only significant addition to ASA Z35.1-1941 is the current inclusion of a WARNING sign to be used along with the original DANGER and CAUTION signs.

Recent View of Accident Prevention Signs

Hazard level and sign format are specified for WARNING signs in SAE J115 Sep 79 (1979), ANSI Z535.4 (1989), and SAE J115 Feb 95 (1995). Basically the WARNING sign is used to indicate that the hazard or unsafe practice could result in severe injury or death. The 1979 SAE standard specifies yellow background with black lettering for WARNING signs; however, the 1995 SAE standard specifies black lettering and an orange background which is consistent with the recommendations of ANSI Z535.4.

These dates are included because they are important in the event of injury and litigation. Obviously dated standards apply only to machines manufactured after the date the standard was adopted. Typical accident scenarios generally involve a situation in which a Danger or Caution (and more recently the Warning) sign might become the focal issue. For some machines, it is not possible to remove the hazard using proper design techniques or by guarding. Frequently it is necessary to warn users not to remove guards.

Chapter 6 of the text by Schoff and Robinson (1991) is titled "Safety Warnings" and contains an excellent treatment of warnings written from a product liability perspective. Sample warnings are shown; however, unfortunately they are not presented in color. Sample pictogram type warnings are also presented. Pictograms are currently becoming more common when used along with the appropriate "signal word" Danger, Warning, or Caution.

Schoff and Robinson (1991) indicate that an adequate warning must do four things:

Identify the gravity of the risk;
Describe the nature of the risk;
Tell the user how to avoid the risk, and
Be clearly communicated to the person exposed to the risk.

The gravity of the risk, leads automatically to the choice of the appropriate "signal word."

DANGER	Hazard or unsafe practice will result in severe injury or death
WARNING	Hazard or unsafe practice could result in severe injury or death
CAUTION	hazard or unsafe practice could result in minor injury or property Damage

These basic guidelines are entirely appropriate when selecting an accident prevention sign for a particular application. Note again the distinct sign colors associated with each level of hazard.

Sign Examples

The choice of signal word (Caution, Warning, Danger) has changed little since 1941 (only the addition of Warning). The hazards are still identified as those that may, could, or will cause moderate to serious injury (or death) if not avoided. The safety alert symbol format (triangle with exclamation point) is shown in Figures 3 a, b, c. The standard recommends that the word message "should be concise and readily understood." The word message obviously should not include mundane features such as general operating instructions for the machine. The "pictorial should be readily understood and should effectively communicate the message." Pictorials currently in use include such things as bloody amputated fingers, legs caught in screw conveyors, arms, and fingers

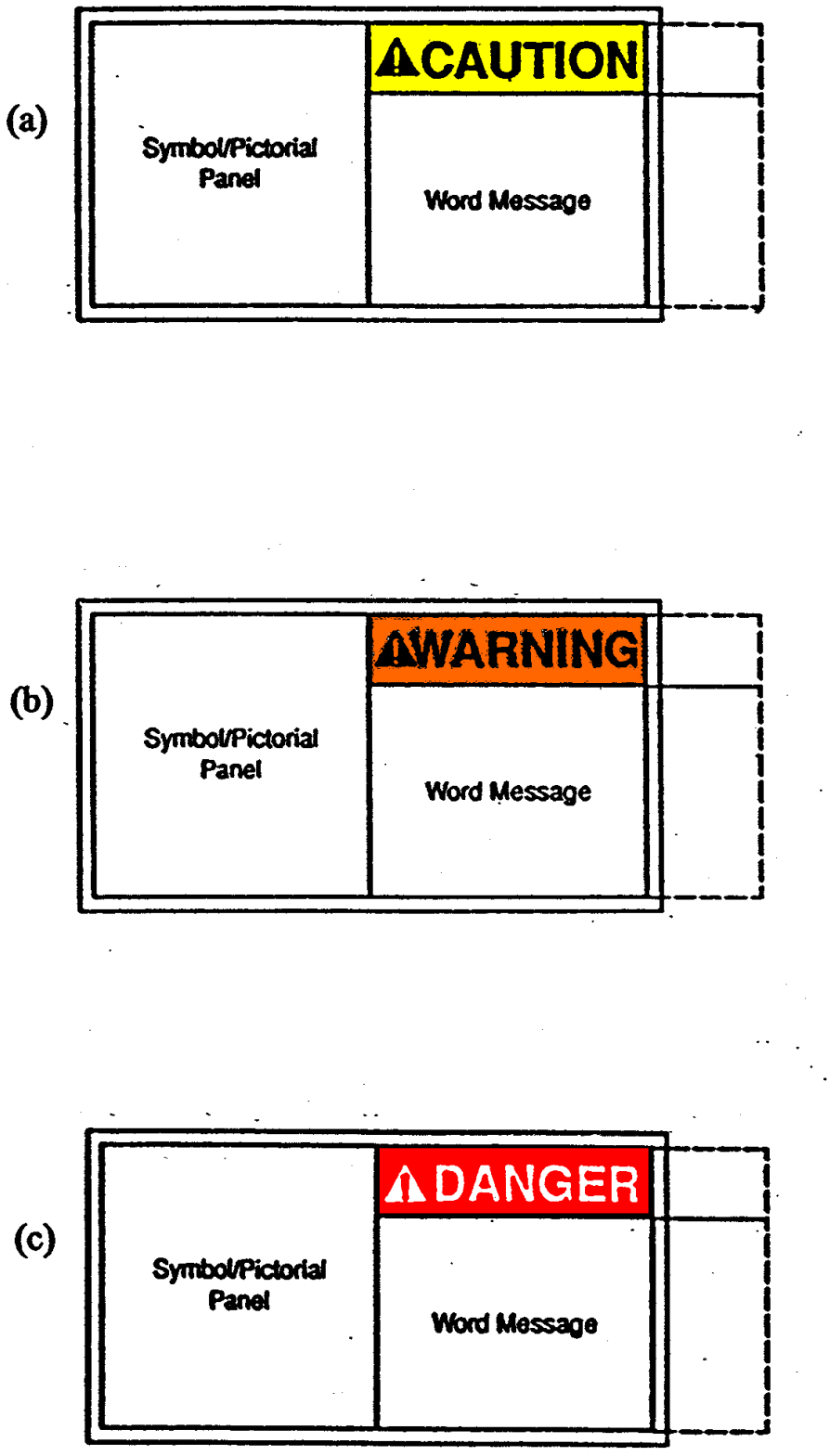

FIG 3: Shows the format suggested for CAUTION, WARNING, and DANGER Signs in SAE J115 Feb95 (1995).

enmeshed in rotating gears, objects being thrown into eyes, etc. SAE J115 Feb 95 (1995), the most current version of this standard, recommends that signs be readily visible to the intended viewer and that the sign be viewed in time for the user to take appropriate action to avoid the hazard. Recommendations are also offered covering the expected life (durability) and maintenance of accident prevention signs. It is suggested that operator manuals contain information regarding maintenance and replacement of accident prevention signs.

FIG. 4. WARNING Sign on ATV Containing all Proper Elements and Color.

Note the effective presentation of the pictogram in Figure 4.

FIG. 5. WARNING Sign designated using Incorrect Color and Format.

The red, white, and black colors should only be used for DANGER signs. The selected hazard level (signal word) appears proper.

FIG. 6. WARNING Sign on Visor of Ford Truck.

Figure 6 contains all proper elements including a good pictogram. Note, however, that the background color should be orange as opposed to yellow.

FIG. 7. WARNING Sign Which Uses Incorrect Colors and Format.

This sign uses red color for the signal word and a black message on an aluminum-colored background. Colors are completely inappropriate.

FIG. 8. WARNING Sign Presented in Colors and Format reserved for DANGER Signs.

Note that this particular sign is concerned with removal of a guard. The signal word appears selected at the appropriate level (Schoff and Robinson, 1991).

FIG. 9 DANGER Sign Presented in Proper Colors.

In Figure 9 colors are properly selected for the safety alert symbol and the pictorial properly conveys the intended message.

(a)

(b)

(c)

FIG. 10: Ford 555E/New Holland Back Hoe/Loader with the appropriate WARNING.

Equipment with WARNING

The back hoe/loader in Figures 10 (a), (b), (c) was observed operating on the campus at Mississippi State University. It is sometimes necessary to elevate the bucket in the backhoe in order to perform required maintenance. I have personally investigated several fatal accidents where hydraulically elevated unsupported machine elements fell onto workers as they performed maintenance. Ford/New Holland has designed this machine with an arm that can be swung into place to mechanically support the bucket (loader) in a raised position when work is being performed. Note that the associated WARNING sign on Figure 10 (c) shows in a pictorial form, proper use of the support arm and the hazard associated with working on an unsupported raised loader.

Schoff and Robinson (1991) recommend the following appropriate strategies concerning selection and use of accident prevention signs:

Make warnings consistent;
Never mix general instructions with warnings;
Following existing guidelines (standards);
Place warning near the hazard;
Make the warning readable; and
Ensure label durability.

If these suggestions are followed, it is not likely that your product will be claimed to be unreasonably dangerous due to lack of proper warnings.

Conclusions

Parsons et al. (1999) presents an excellent summary of warnings research that reviews and summarizes data from more than 150 laboratory and field studies published during the last 15 years. One interesting observation presented in this paper is that "laypersons may not recognize that a warning is poor until they see a good one." An excellent start toward producing a "good" warning can be assured by ensuring that it complies with standards which have been available for a more than 50 years. When investigating an accident scene or equipment, where accident prevention signs were (or should have been) utilized, it is important to document whether the signs conform to the accepted standards published more than 50 years ago. Just as the general public knows that STOP signs are standardized with a red background with white border and lettering, they should be made aware that there are also standardized colors and format for signs commonly used in the workplace. This applies especially to engineering students who, as future manufacturers and plant mangers, should be informed that there are indeed accident prevention signs, and they should have the ability to find the information concerning warning standards should the need arise.

References

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Richard E. Forbes

Richard E. Forbes is Professor Emeritus of Mechanical Engineering at Mississippi State University (MSU) and Associate Director of the Industrial Assessment Center. He taught in the Mechanical Engineering Department and he has over thirty years of litigation-related experience; working on behalf of both plaintiffs and defendants.

Mary C. Emplaincourt

Mary C. Emplaincourt in an Instructor of Mechanical Engineering at Mississippi State University and, also, serves as Associate Director of the Industrial Assessment Center. She holds a master's degree in Industrial Engineering from MSU teaching for Departments of Mechanical Engineering and Industrial Engineering since 1990.