

On the Symbiotic Relationship Between Warnings Research and Forensics

Kenneth R. Laughery, Rice University, Houston, Texas, and **Michael S. Wogalter**, North Carolina State University, Raleigh, North Carolina

Objective: We describe a major factor in research in warnings – namely, forensics. **Background:** During the past three decades, much of the empirical warnings research has been published in human factors and ergonomics (HF/E) literature. A major impetus to that research has been concurrent activity by HF/E professionals participating as expert witnesses in product liability and personal injury cases in which there is a claim of failure to adequately warn about associated hazards. **Method:** We review how the issues in forensics can identify researchable questions. This effort has prompted important questions to be addressed that have resulted in publications. Two examples are provided: vehicle seat recline and explicitness. **Results:** The research has contributed to theory and model building of the processing involved. The research prompted by practical forensic issues can contribute to knowledge that is not limited in scope to particular instances, as is sometimes ascribed to applied research; it can also offer confirmatory support for theory or its modification. **Conclusion:** A practice-driven approach to the initiation of research can benefit not only application and practice but also theory. **Application:** Results in the warnings research domain can enhance safety and aid decisions in forensic contexts.

INTRODUCTION

Warnings are communications intended to convey hazard information, enhance safe behavior, and serve as reminders for purposes of decreasing accidents, injury, illness, and property damage. Much of the research about warnings has been published in the human factors and ergonomics (HF/E) literature. The considerable growth in warnings research is indicated by two substantial books – namely, a compendium of annotated abstracts of warnings articles by Miller and Lehto (2001) and the *Handbook of Warnings*, edited by Wogalter (2006b). The hundreds of references in the Miller and Lehto volume and the 63 chapters contained in the handbook reflect a substantial level of research activity and progress addressing a broad array of warnings issues. Also, there have been several substantial reviews over the past decade (e.g., Laughery & Wogalter, 2006; Parsons, Seminara, & Wogalter, 1999;

Rogers, Lamson, & Rousseau, 2000; Wogalter & Laughery, 2006).

In this article, we take a somewhat different approach from the above-mentioned reviews in that we consider another co-occurring activity and its influence on warnings research – namely, the role of an expert witness in civil litigation (product liability and personal injury claims) in the United States (Askren & Howard, 2005). This activity has been a major spur or impetus for research on warnings. An indication of the involvement and progress of HF/E specialists in this role is the recent publication of the 38-chapter *Handbook of Human Factors in Litigation* (Noy & Karwowski, 2005).

This important and interesting relationship between warnings research and human factors experts is featured in this review. The tie that connects the two is the claim of inadequate warnings in lawsuits. According to the U.S. legal system, product manufacturers have an obligation to

provide warnings and instructions sufficient to permit consumers to use a product safely or to make an informed choice not to use the product (Madden, 1999). Warnings can be considered part of the interface between humans interacting with products (and environments), a perspective that places them squarely in the domain of the HF/E discipline (Laughery, 2006).

At annual meetings of the Human Factors and Ergonomics Society (HFES), the intermingling of warnings and forensics is much more apparent than is seen in the archival warning research that may have been prompted by it. Thus, although the connection may be frequently talked about among warning researchers, the driving force for the research as a result of expert witnessing by human factors specialists has not received much attention in the empirical research literature. In this report, we show the unique influence of litigation on a research literature that would be less developed than without it.

Although this review addresses the relationship between warnings research and warnings issues in litigation, it should be acknowledged that factors other than expert witness work have also played substantial roles in motivating and guiding warnings research. Research has addressed relevant *theoretical* issues (Lehto, 2006; Wogalter, 2006a), and its application has been carried out in other contexts, such as complex systems development (e.g., transportation, air defense). For example, in the transportation context, on-vehicle warning labels combined with public information campaigns in the late 1990s addressed the hazards of children in front of vehicle airbags. This warning system has resulted in greater public knowledge of the safety issues, fewer children being placed in front of airbags, and fewer child fatalities as a result of airbag deployment.

Likewise, in other transportation areas, warning-related research is now considerable and broad (e.g., traffic signs and markings). In this review, we mainly discuss visual warnings in the context of products, equipment, and environment (e.g., labels, signs, product manuals). In the past few decades, there has been a large and growing body of research on auditory warnings, but a complete review of this and other related areas would warrant separate articles.

By definition, expert testimony deals with areas outside the knowledge domain of the trier

of fact (the judge and/or jury). The role of the expert is to educate the judge and/or jury with regard to information that is beyond their “common sense” or personal experience. The role of the HF/E expert in a warnings case includes evaluating and giving opinions regarding a number of issues, including the following (Laughery & Wogalter, 2005): Is a warning needed? Is an existing warning or warning system adequate? What would an adequate warning system be? Would an adequate warning system make a difference (effectiveness)? The role includes assembling literature pertinent to these issues and the facts of the case.

In a failure-to-warn claim, the plaintiff’s proof must establish causation. In its most elementary form, such proof will show, for instance, that had the seller of a product supplied an adequate warning, the injured claimant would have avoided injury. The evidence must be as such to support a reasonable inference, rather than a guess, that the existence of an adequate warning may have prevented the accident. A defendant may argue that even with an adequate warning, the plaintiff would have acted in an identical way and would have suffered the injury. There is, of course, usually much more to the claims than our simplified description of opposing positions. The warning expert’s role is to aid the court in making decisions.

THE WARNINGS EXPERT AND WARNINGS RESEARCH

There are several reasons why the HF/E specialist filling the warning expert role may also be interested and active in warning research. First, to be accepted and perform as an expert, one must be knowledgeable about the subject matter. This knowledge includes an appreciation and understanding of theory, methodology, content, and the current research literature. A second, and related, reason for the expert’s involvement in research concerns the adversarial nature of the litigation context. The expert can expect to be tested (questioned) about the subject matter before being accepted and permitted to give opinions. Having a thorough knowledge of the research literature plays an important role in acceptance, and having authored relevant publications adds to the likelihood of acceptance.

A third reason for the warning expert’s interest and participation in warnings research is that

the scientific knowledge as reflected in the research literature serves as the basis for the expert's opinions. It should be noted that the expert is in the potentially powerful position of being able to offer opinions (which fact witnesses cannot). But the opinions must be based on substance and evidence, not just an educated guess. Again, given the adversarial setting, the expert can expect to be challenged when providing analyses and opinions regarding the warnings issues. The sparse warnings research literature that existed in the late 1970s was limited in its ability to support data-based opinions about warning design and effectiveness. As a result of increasing involvement of HF/E experts in the litigation context, researchable questions were identified that in turn led to warnings research. Furthermore, this need for a research basis in expert opinion was strongly influenced by a U.S. Supreme Court decision in the early 1990s.

The role of expert witness in the U.S. federal court system, including the HF/E expert addressing warnings issues, was dramatically changed by the now famous *Daubert* case (*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 1993; Papinchock & Landy, 2005). As noted, expert testimony deals with areas outside the knowledge domain of the trier of fact. The *Daubert* decision was intended to prevent the trier of fact from even hearing expert testimony that lacks scientific foundation. In short, the Supreme Court decision required that expert opinion have a scientific basis and gave several criteria for U.S. federal courts to employ in determining whether there is an adequate scientific basis for an expert's opinions. One of the criteria was whether the opinions are based on evidence contained in peer-reviewed publications. Thus, the requirement that the warning expert "use" quality research was promoted by the *Daubert* decision.

EXAMPLES OF LITIGATION INFLUENCING WARNINGS RESEARCH

Many of the warnings issues addressed in research have been suggested by an HF/E expert's analysis of personal injury and product liability litigation cases. The forensics context has led to research ideas that may not have otherwise been suggested by theory-driven endeavors. Two examples of how the litigation context influenced warning research are described. One demon-

strates how vehicle seat recline cases led to warnings research. The other is how the use of non-specific warnings led to investigations of the explicitness factor.

Vehicle Seat Recline

Since the mid-1990s, there have been a number of legal cases involving reclined seats in vehicles. In these cases, vehicle accidents occurred in which an occupant of the right front seat was injured or killed while riding with the seatback reclined. Crash research data and restraint system experts' analyses have established that when the occupant's seatback is reclined beyond a point where the shoulder belt is no longer in contact with the torso, the effectiveness of the restraint system is reduced or negated. Two questions emerge from analyzing such cases. First, are the hazards associated with reclining the seat while the vehicle is moving open and obvious? That is, will the occupant realize the hazard when the seatback is reclined and the shoulder belt is off the torso? This is a risk perception question.

Several studies carried out and reported by different HF/E experts involved in the litigation explored this issue. Two studies (Leonard, 2006; Leonard & Karnes, 1998) found that significant numbers of people reported having ridden in vehicles with the seat reclined, and the majority were not aware of the hazards. Two other studies (Paige & Laughery, 2003; Rhoades & Wisniewski, 2004) asked about the hazard associated with various reclined positions. Both studies showed that when viewing the reclined positions, participants rated the hazards greater with more recline. What these studies seem to show is that people do not think about the restraint safety issue when reclining the seat but will recognize the hazard if it is called to their attention by observing a reclined occupant in a research context. These results suggest that giving a warning calling attention to the hazard could be effective.

A second question arose in the analyses of seat recline cases – namely, the location of a warning. The specific question is where such a warning should be placed. It turns out that many vehicle manufacturers do warn about the hazard of reclining the seatback while the vehicle is moving. These warnings, in virtually all instances, are located in the vehicle owner's manual. Some of the warnings in the manuals can probably be regarded as poor, whereas some of them, such as

in manuals for General Motors' vehicles, appear adequate. However, several studies (e.g., Leonard & Karnes, 2000) have now been published showing that only about 5% of vehicle owners report reading their owner's manual cover to cover. Rather, they consider the manual a reference source to be used when some specific information is needed. Thus, research emanating from the litigation work shows that relying exclusively on warnings placed within the owner manuals about seatback recline hazards are not likely to be effective.

Explicitness

One category of warnings issues frequently encountered by HF/E expert witnesses might be referred to as *explicitness issues*. Explicitness of hazard, consequence, and instructional information has been shown to be important in warning effectiveness. Two examples of nonexplicit information in warnings repeatedly encountered in legal cases have been among the motivators to carry out research addressing the issue of explicit information in warnings.

The first example is "May be hazardous to your health." It is a classic nonexplicit consequences statement often encountered on products such as solvents and medications. Not only does it fail to tell us what the nature of the consequence is (a chemical burn on the skin, side effects such as stroke, etc.), but it also fails to tell how serious the outcome may be.

In the late 1990s to the early 2000s, lawsuits have been filed against manufacturers of over-the-counter dietary supplements containing ephedra. There were several potentially serious side effects associated with these products, including stroke and heart attack, and eventually the U.S. Food and Drug Administration banned the ephedra ingredient. Several of these products, however, did not note the more serious side effects such as stroke or heart attack, and the statement "May be hazardous to your health" was included in the warnings. As a result of this litigation, several studies (e.g., Kalsher, Wogalter, & Laughery, 2004) have been carried out and reported addressing the importance of explicit consequences information in warnings on the dietary supplement products.

The second example is another warning statement frequently encountered: "Use with adequate

ventilation." This example is a classic nonexplicit instruction statement. It appears in the warnings on paints, solvents, and a variety of products that produce vapors, dusts, and so on. Does opening a window, using a fan, wearing a dust mask, or using a hood with an enclosed air supply satisfy the instruction? The point, of course, is that the warning does not tell us. However, based on such statements in warnings in the litigation context, it may be stated that accumulated research demonstrates that explicitness is an important aspect of warnings design and effectiveness. There are many other examples of nonexplicit instruction information in warnings, and the issue has received considerable research attention (e.g., Frantz, 1994). Laughery and Smith (2006) have reviewed this research and describe its implications.

SUMMARY

The increasing role of the expert witness in warnings issues in civil litigation over the past 30 years has resulted in HF/E specialists drawing heavily on the warnings research literature as a scientific basis for analyses and opinions. This requirement for a scientific basis has in turn resulted in the identification of gaps in the research literature and led to research addressing significant warnings issues. The questions identified and studied have spanned a wide range of warning design and effectiveness issues.

This interaction between the expert role and warnings research has contributed to the research progress. Factors such as explicitness play an important role in warnings design and effectiveness. Other examples of factors that have been identified and studied in the research literature include conspicuity, use of pictorials, cost of compliance, familiarity, and social modeling. Research results addressing these factors have been reported in *Human Factors* (Friedman, 1988; Hancock, Rogers, Schroeder, & Fisk, 2004; Wogalter, Allison, & McKenna, 1989; Wogalter et al., 1987).

The benefits of this symbiotic interaction have been twofold. First, by extending our knowledge and understanding of warning system design and effectiveness, it has contributed to the potential for warnings to be effective in improving product and environmental safety. Second, it has enabled HF/E specialists to better fulfill their role as warning experts in civil litigation.

REFERENCES

- Askren, W. B., & Howard, J. M. (2005). A road map for the practice of forensic human factors and ergonomics. In I. Y. Noy & W. Karwowski (Eds.), *Handbook of human factors in litigation* (pp. 5.1–5.16). Boca Raton, FL: CRC Press.
- Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 951 F.2d 1128 (9th Cir. 1991), vacated, 113 S.Ct.2786 (1993).
- Frantz, J. P. (1994). Effect of location and procedural explicitness on user processing of and compliance with product warnings. *Human Factors*, 3, 532–546.
- Friedman, K. (1988). The effect of adding symbols to written warning labels on user behavior and recall. *Human Factors*, 30, 507–515.
- Hancock, H. E., Rogers, W. A., Schroeder, D., & Fisk, A. D. (2004). Safety symbol comprehension: Effects of symbol type, familiarity and age. *Human Factors*, 46, 183–195.
- Kalsher, M. J., Wogalter, M. S., & Laughery, K. R. (2004). Assessing people's knowledge and beliefs about dietary supplements. In *Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting* (pp. 1736–1740). Santa Monica, CA: Human Factors and Ergonomics Society.
- Laughery, K. R. (2006). Safety communications: Warnings. *Applied Ergonomics*, 37, 467–478.
- Laughery, K. R., & Smith, D. P. (2006). Explicit information in warnings. In M. S. Wogalter (Ed.), *Handbook of warnings* (pp. 605–615). Mahwah, NJ: Erlbaum.
- Laughery, K. R., & Wogalter, M. S. (2005). The warning expert. In I. Y. Noy & W. Karwowski (Eds.), *Handbook of human factors in litigation* (pp. 30.1–30.14). Boca Raton, FL: CRC Press.
- Laughery, K. R., & Wogalter, M. S. (2006). Designing effective warnings. In R. C. Williges (Ed.), *Reviews of human factors and ergonomics* (pp. 241–271). Santa Monica, CA: Human Factors and Ergonomics Society.
- Lehto, M. R. (2006). Optimal warnings: An information and decision theoretic perspective. In M. S. Wogalter (Ed.), *Handbook of warnings* (pp. 89–108). Mahwah, NJ: Erlbaum.
- Leonard, S. D. (2006). Who really knows about reclining the passenger seat? In *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting* (pp. 855–859). Santa Monica, CA: Human Factors and Ergonomics Society.
- Leonard, S. D., & Karnes, E. W. (1998). Perception of risk in automobiles: Is it accurate? In *Proceedings of the Human Factors and Ergonomics Society 42nd Annual Meeting* (pp. 1083–1087). Santa Monica, CA: Human Factors and Ergonomics Society.
- Leonard, S. D., & Karnes, E. W. (2000). Compatibility of safety and comfort in vehicles. In *Proceedings of the IEA 2000/HFES 2000 Congress* (pp. 3.357–3.360). Santa Monica, CA: Human Factors and Ergonomics Society.
- Madden, M. S. (1999). The law relating to warnings. In M. S. Wogalter, D. M. DeJoy, & K. R. Laughery (Eds.), *Warnings and risk communication* (pp. 315–330). London: Taylor & Francis.
- Miller, J. M., & Lehto, M. R. (2001). *Warnings and safety instructions: An annotated bibliography* (4th ed.). Ann Arbor, MI: Fuller Technical Publications.
- Noy, I. Y., & Karwowski, W. (Eds.). (2005). *Handbook of human factors in litigation*. Boca Raton, FL: CRC Press.
- Paige, D. L., & Laughery, K. R. (2003). Risk perception: The effects of technical knowledge – or lack of it. In *Proceedings of the XVth Triennial Congress of the International Ergonomics Association* (pp. 5.427–5.430). Seoul, Korea: International Ergonomics Association.
- Papinchock, J. M., & Landy, F. J. (2005). The influence of Daubert on expert witness testimony: The human factors context. In I. Y. Noy & W. Karwowski (Eds.), *Handbook of human factors in litigation* (pp. 7.1–7.12). Boca Raton, FL: CRC Press.
- Parsons, S. O., Seminara, J. L., & Wogalter, M. S. (1999). A summary of recent research on warnings. *Ergonomics in Design*, 7(1), 21–31.
- Rhoades, T. P., & Wisniewski, E. C. (2004). Judgments of risk associated with riding with a reclined seat in an automobile. In *Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting* (pp. 1136–1139). Santa Monica, CA: Human Factors and Ergonomics Society.
- Rogers, W. A., Lamson, N., & Rousseau, G. K. (2000). Warning research: An integrative perspective. *Human Factors*, 42, 102–139.
- Wogalter, M. S. (2006a). Communication-human information processing (C-HIP) model. In M. S. Wogalter (Ed.), *Handbook of warnings* (pp. 51–61). Mahwah, NJ: Erlbaum.
- Wogalter, M. S. (Ed.). (2006b). *Handbook of warnings*. Mahwah, NJ: Erlbaum.
- Wogalter, M. S., Allison, S. T., & McKenna, N. A. (1989). Effects of cost and social influence on warning compliance. *Human Factors*, 31, 133–140.
- Wogalter, M. S., Godfrey, S. S., Fontenelle, G. A., Desaulniers, D. R., Rothstein, P. R., & Laughery, K. R. (1987). Effectiveness of warnings. *Human Factors*, 29, 599–612.
- Wogalter, M. S., & Laughery, K. R. (2006). Warnings and hazard communications. In G. Salvendy (Ed.), *Handbook of human factors/ergonomics* (3rd ed., pp. 889–911). New York: Wiley.

Kenneth R. Laughery is an emeritus professor of psychology at Rice University. He received his Ph.D. in psychology at Carnegie Mellon University in 1961.

Michael S. Wogalter is a professor of psychology at North Carolina State University. He received his Ph.D. in psychology at Rice University in 1986.

Date received: November 27, 2007

Date accepted: April 16, 2008