Human Error – Expert Article Examining the Role of Human Factors

ARTICLE

In this article, Human Factors Expert, Dr. Nancy Grugle provides an introduction to the science of human factors and the concepts utilized by human factors experts to design products and environments that minimize human error related mishaps.

HUMAN ERROR: APPLYING HUMAN FACTORS TO YOUR CASES

Human error is estimated to cause 94% of all vehicle crashes and between 75% and 95% of all industrial accidents. With such high estimates of human error in accidents, human factors is often a critical consideration in legal disputes.

Human factors experts have specialized knowledge of human capabilities and limitations and how humans interact with technology and the environment. They analyze the design, operation, maintenance, and use of products, systems, and environments to determine what proper design measures, if any, were taken into account by a product manufacturer or what proper operational measures were taken by an employer to minimize human error. Human Factors experts are also frequently retained to evaluate the actions of individuals within particular environments to help understand the audible, visual, and instructional cues that guided their behavior.

Our human factors experts apply their expertise across various disciplines; in this article we will focus on vehicle crashes, product liability, and workplace safety applications.

ARTICLE CONTENTS

- Human Factors in Transportation Cases
- Human Factors in Product Liability Cases
- Human Factors in Workplace Safety Cases

HUMAN FACTORS IN TRANSPORTATION CASES

Human factors experts frequently analyze visibility/conspicuity and perception-reaction time, but human factors experts also have specialized knowledge in specific aspects of transportation cases. Areas of investigation include drowsy driving, distracted driving and roadway and work zone set up and design.

Drowsy Driving

The American Automobile Association (AAA) estimates that drowsy driving causes over 16% of deadly crashes and over 12% of injury crashes on U.S. roadways. Human factors experts with specialized knowledge in sleep deprivation and fatigue analyze a driver's sleep/wake history to determine whether the driver was sufficiently sleep-deprived or fatigued to cause impairment and whether fatigue played a role in the collision.

Although truck drivers and shift workers are particularly susceptible to drowsy driving, drowsy driving is an epidemic that affects all drivers. The critical factor is a person's sleep/wake history, not the particular activity that a person was performing while awake. It is also important that commercial drivers can be in violation of hours-of-service (HOS) regulations and not be fatigued and, conversely, a driver can be in compliance with HOS regulations and be fatigued.

[For more information see our article on Sleep Deprivation in Commercial Driving (/articles/asleep-at-the-wheel-sleep-deprivation-and-fatigue-in-commercial-trucking)]

Distracted Driving

In 2014, 3,179 people were killed, and 431,000 were injured in crashes involving distracted drivers (www.distraction.gov). While it is widely known that all distractions increase crash risk, there are several methods that human factors experts use to measure the crash risk of different types of distracted driving and to determine if a particular device or activity is, in fact, distracting to drivers.

Driving distractions can be categorized into three main areas: visual, manual, and cognitive. Visual distractions are objects that take the driver's visual attention away from the road and driving environment. Manual distractions are objects that take a driver's hands off the wheel. Cognitive distraction involves a driver using their brain to process information not related to the driving task.

Any activity that takes a driver's eyes off the road for more than two seconds doubles the risk of a crash; however, distractions that require a combination of visual, manual, and cognitive resources are the most risky. For example, texting while driving raises a driver's crash risk by 23 times. As shown in Figure 1, a driver who is texting is manually distracted by holding and manipulating the phone, visually distracted by looking at the screen, and cognitively distracted by the content of the text conversation.

Figure 1. Distraction from a cell phone

[For more information see our article on Distracted Driving (/articles/distracted-driving-expert-witness)]

Roadway Design

Human factors experts also analyze the impact of the design and condition of a roadway environment on a driver's performance. Investigations include determining whether the traffic control devices, pavement markings, or signage were visible, whether they were consistent with a driver's expectations, whether they caused the driver to take a particular action, and whether they were sufficient to prevent a collision.

Key human factors issues in roadway design cases include expectancy and positive guidance. Expectancy relates to a driver's readiness and ability to respond to situations, vehicles, and information that they encounter on the

roadway in predictable and successful ways. This includes a driver expecting traffic control devices to operate in accordance with established conventions so they can respond safely and appropriately. Positive guidance is the concept that drivers can safely avoid hazards when the roadway environment provides sufficient information where/when it is needed and in a form that is easy to understand. Positive guidance is provided to drivers through traffic signs, pavement markings, traffic control devices, and perhaps most importantly, by the view of the road ahead. When drivers' expectancies are violated or when positive guidance is not provided, drivers may respond more slowly, incorrectly, or not at all.

As an example, the traffic control devices shown in Figure 2 provide positive guidance to drivers so they can safely navigate the work zone. The traffic light tells drivers when it is safe to proceed, the barrels guide their path, and the height clearance sign is provided so that trucks can safely navigate under the temporary traffic light.

Figure 2. Work zone design

HUMAN FACTORS IN PRODUCT LIABILITY CASES

In addition to analyzing product warnings and instructions, human factors experts apply the hazard control hierarchy to the design of product user interfaces. Human factors areas of investigation in product liability cases include feedback, affordances, compatibility, and foreseeable use and misuse.

Feedback

Feedback is the visual, auditory or haptic information that the product gives the user so they can operate and maintain it correctly and safely. Adequate feedback minimizes user error. However, when operators are not provided with adequate feedback, they may respond incorrectly or not at all.

Affordances

The term affordance refers to the idea that the characteristics of an object "suggest" how an object may be interacted with to a user. For example, a knob affords twisting, a button affords pushing, and a handle affords pulling, etc. When the affordance conveyed to the user conflicts with how the product actually works, errors result.

Control-Display Compatibility

Movement or control-display compatibility refers to the relationship between the movement of displays and controls and the response of the system being displayed or controlled. User error is minimized when controls and displays are compatible. When users are confronted with a product where the control and display are incompatible or, in other words, their actions do not produce the expected result, their reaction time is slower and errors are made.

Foreseeable Use and Misuse

Products should be designed to be safe under all conditions of foreseeable use and misuse. User testing is one method to identify the how actual users will interact with a product. User testing can also help engineers and designers identify potential hazards that users may encounter while using a product.

HUMAN FACTORS IN WORKPLACE SAFETY CASES

Work Design/Occupational Ergonomics

Human factors is also applied to the design of a worker's job. This means adjusting the requirements of a worker's physical and mental tasks to accommodate his or her capabilities and limitations. Work design concepts include workstation design and ergonomics, equipment user-interface design, and control-display design. If, for example, the job requires lifting of parts or equipment that is heavy, a mechanical lift should be provided to prevent injury. Or, if an inspection task requires sustained attention or vigilance, technology should be provided to assist the worker. In some cases, the human's role in a particular job should be eliminated altogether. When work tasks, equipment, and facilities are designed in accordance with human capabilities and limitations, the number of errors and injuries are minimized.

Fatigue and Shift Work

Human factors experts also address fatigue and shift work. Critical aspects of shift work that affect safety include long shifts, overnight shifts, and irregularly scheduled shifts. Working long hours and overtime prevents employees from getting enough hours of sleep to ensure proper functioning throughout the day. Overnight shifts and irregularly scheduled shifts disrupt a worker's ability to get sufficient quality and quantity of sleep because the work schedule conflicts with the body's circadian rhythm. The circadian rhythm is a biological function that regulates a person's wakefulness and sleepiness. A conflict occurs when the work shift requires a worker to be awake during the biological night and asleep during the biological day. As a result of this conflict, shift workers are often chronically sleep-deprived. Sleep-deprived workers are 70 percent more likely to be

involved in work-related accidents and workers reporting disturbed sleep and excessive daytime sleepiness are almost twice as likely to die in a work-related accident.

Workers that exhibit signs of fatigue such as falling asleep on rest breaks as depicted in Figure 3 are an indication to employers that fatigue and/or shift work is a safety issue that needs to be addressed. The risk of fatigue-related work accidents is decreased when employers educate employees about the effects of shiftwork and when work schedules are optimized to allow employees to get adequate restorative sleep.

Figure 3   Worker Fatigue   **Robson Forensic** THE EXPERTS

Figure 3. Shift worker fatigue
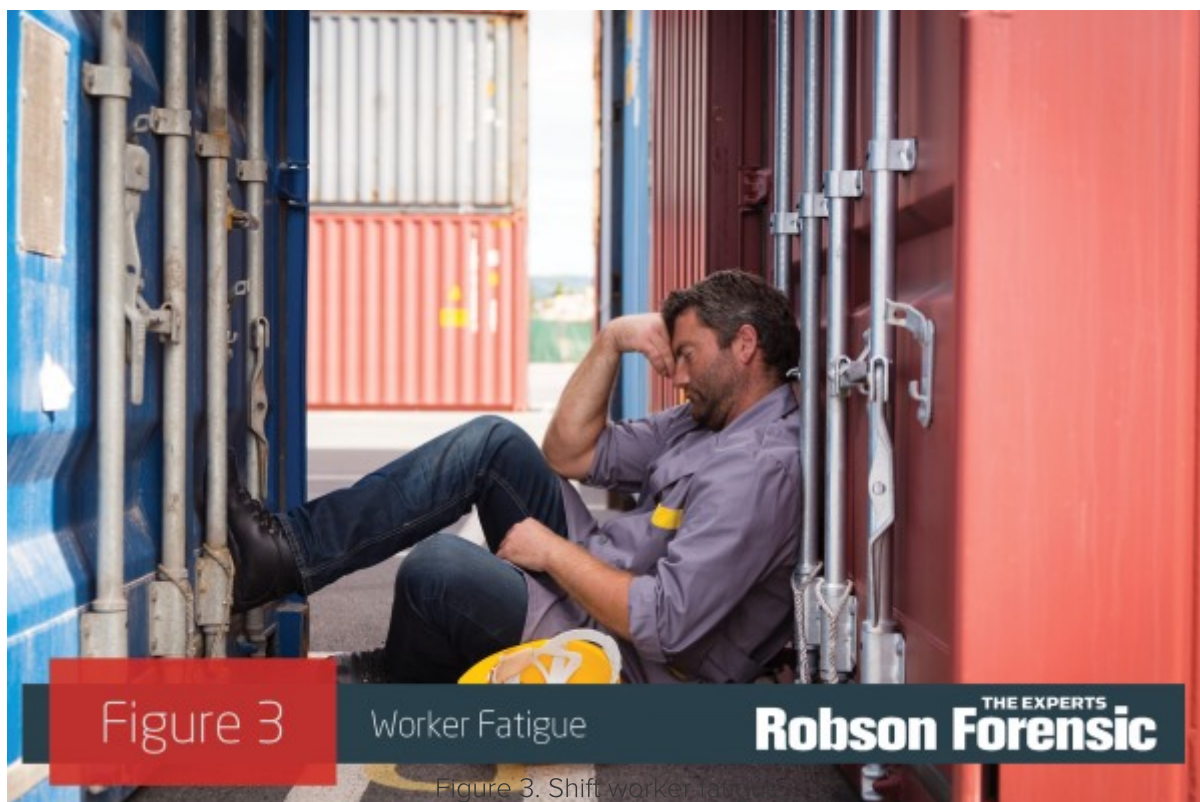
[For more information see our article on Sleep Deprivation in Industrial Accidents (/articles/shift-work-sleep-deprivation-and-industrial-accidents-expert-article)]

HUMAN FACTORS EXPERTS

Human Factors is a specialized area of expertise that can be applied to many types of cases involving human error. Our human factors experts have spent many years in industry, government, and academia researching human performance and designing consumer and commercial products, roadway environments, workplace safety and training programs, and warnings and instructions. Our experts use a combination of accident analysis techniques, knowledge of human behavior and performance, and experience investigating human error to evaluate the human factors aspects of each case.

For more information visit our Human Factors (/practice-areas/human-factors-expert) practice page.

FEATURED EXPERT

Nancy Grugle, Ph.D. (/experts/human-factors-grugle)

Human Factors Expert

Dr. Nancy Grugle is an expert in forensic human factors. She applies her expertise to forensic investigations covering the range of issues discussed in this article, with specialized expertise in the area of sleep deprivation and fatigue, driver performance, and user interface design.

Dr. Grugle conducted research on the effects of sleep deprivation at the Walter Reed Army Institute of Research and has been published on the topic in national and international peer-reviewed journals. Dr. Grugle also conducted research on distracted driving while an Assistant Professor of Industrial and Manufacturing Engineering at Cleveland State University. She received competitive research grants from the National Science Foundation, the Ohio Department of Transportation, and the Cleveland State University Transportation Center. As a practicing human factors engineer in industry, Dr. Grugle designed product user interfaces, developed warnings and instructional material, and conducted user testing.