

The Role of Human Factors in Process and Occupational Safety

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Industries are the backbone of all developed and developing nations, and their safe operations a primary collective goal. Yet, a plethora of hazards exist that if left uncontrolled can lead to incidents that cost lives, time, and money in addition to loss of employee morale and public trust. According to the National Safety Council's Industry Facts, workplace injuries and death cost the U.S. economy over \$160 billion in 2017.¹ This figure includes wage and productivity losses, medical expenses, employers' uninsured costs, damage to motor vehicles, and fire losses. If we factor in additional property damage and environmental impact, the figure rises further.

While occupational injury and illness incidence rates published by the Bureau of Labor Statistics have decreased in recent years,² the occurrence of serious injuries and fatalities (SIFs) have declined at a significantly slower rate.³ This trend suggests that scientists, engineers, and other safety professionals should revisit long-held accident causation theories holding that near misses—incidents that could have resulted in SIFs but did not—are precursors of future SIFs. Safety professionals have historically examined near misses to understand how to better prevent serious incidents that occur less frequently than minor ones due to the existences of effective barriers, defenses, and controls. While this practice is not without merit, the above statistics warrant a reconsideration of why SIFs are not decreasing in lockstep with less severe injuries and hint that additional factors may be involved.

Research suggests that human factors shortcomings are often-overlooked contributors to lapses in occupational and process safety and that these oversights may offer some answers to the SIF riddle. In this work we discuss the role of human factors in assessing safety risk, the importance of human factors when performing incident investigation and root cause analysis, and how industry leaders may be able to reduce safety risk by applying human error prevention and mitigation techniques to both occupational and process safety.

The Role of Human Factors in Assessing Safety Risk:

Safety professionals score safety risk by estimating the probability of an adverse event combined with the severity of the event. While low-severity/high-frequency occupational incidents are common among different industries, the risk associated with a potential adverse event in the process industries could be much higher compared to manufacturing sectors due to the relatively high severity of the outcome of such events. Overall risk estimation for both process and occupational safety can depend on several factors, including but not limited to facility type, materials handled, and applicable government regulations.

When assessing the risk imposed by a system, it is also important to understand the roles and actions of the individuals who design, operate, and maintain the system, as well as the likelihood of human error. Exponent partners with clients who seek to minimize the risk of these types of errors, such as an error that could result in the release of toxic and flammable materials, and helps clients to identify critical steps where human error is probable and develop effective interventions.

¹ <https://injuryfacts.nsc.org/work/costs/work-injury-costs/>

² <https://injuryfacts.nsc.org/work/industry-incidence-rates/work-related-incident-rate-trends/>

³ Martin, D.K., & Black, A. (2015). Preventing serious injuries and fatalities: Study reveals precursors and paradigms. *Professional Safety*, 60(09), 35–43.

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Human Factors Contributors to Lapses in Occupational and Process Safety:

Lapses in occupational and process safety are often attributed to safety procedure violations or procedures that were not field verified, insufficient, or otherwise problematic. The following two examples highlight an often-related contributor: human factors issues.

In our first example, a worker in a manufacturing plant fails to verify that a machine has been deenergized and locked out before conducting work. As a result, he is exposed to the hazards of electrical energy and moving parts that can cause serious injury. In our second example, a worker in an oil refinery fails to verify whether flammable gases are present in sufficient quantities inside an empty storage tank before conducting hot work. As a result, he provides a competent source of ignition resulting in a tank explosion with multiple fatalities and property damage. In both of these examples, a worker failed to follow well-established procedure designed to act as a layer of defense in the system. However, there are human factors issues that can affect the reliability of a worker's compliance to procedures. We cannot overlook the role of experience, training, supervision, work conditions, human-machine interfaces, and the overall safety culture within an organization—all of which can affect an individual's ability and/or willingness to adhere to safety procedures. Root cause analyses and corrective action initiatives are common in safety management systems, but research suggests that incident investigators do not consider a broad or deep enough set of potential human factors contributors. As an example, research suggests that roughly 13% of industrial incidents can be attributed

to fatigue, which translates to approximately 125,000 fatigue-related incidents occurring globally each day.⁴ As human fatigue is classically difficult to determine, we suspect that more incidents may have this as a contributing factor than is currently estimated.

An Evolving Regulatory Environment:

The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) has developed a Process Safety Management (PSM) Standard for Highly Hazardous Systems and Materials.⁵ Facilities with threshold quantities of hazardous materials must adhere to this national standard and the assessment of human factors it requires. In recent years, states such as California have introduced safety ordinances that mandate written human factors programs and seek to guide industry on how to address human factors issues.⁶ We expect this trend to continue and anticipate seeing more guidance covering additional situations of over the coming years.

How Exponent Can Help:

Exponent's multi-disciplinary Human Factors team includes experts in hazard identification with years of experience performing root cause analyses of safety incidents across industries. Our investigative experience informs our proactive approach to assessing and mitigating occupational and process safety risks stemming from human factors issues that so often lie at the root of adverse incidents in each domain. Our Human Factors team also regularly assists clients in the legal and insurance industry in evaluating human factors issues associated with industrial accidents and occupational injuries.

⁴ Uehli, K., Mehta, A.J., Miedinger, D., Hug, K., Schindler, C., Holsboer-Trachsler, E., ... & Künzli, N. (2014). Sleep problems and work injuries: a systematic review and meta-analysis. *Sleep medicine reviews*, 18(1), 61–73.

⁵ <https://www.osha.gov/Publications/osha3132.html>

⁶ California Code of Regulations, Title 8, Section 5189.1, Process Safety Management for Petroleum Refineries. https://www.dir.ca.gov/title8/5189_1.html



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