Safety Management — Development of Steel Manufacturing Plant-Specific Safety Plan Case Study

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

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Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

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Steel manufacturing is a hazardous industry that involves regular exposure to potentially dangerous conditions that can lead to serious injuries if not recognized and controlled.[1] Throughout the industry, it is recognized that employees are often the first line of defense against accidents; therefore, training steel manufacturing workers to recognize and mitigate hazards is an important step in accident prevention. Additionally, many regulations that impact the steel manufacturing industry require that employees be trained on the hazards present in their working environments.

However, despite the obvious need for training, safety training has a reputation of being boring and studies indicate that it is also often ineffective.[2,3] Research suggests that these problems may stem from the delivery methods commonly used in industry to administer training.[4,5] Traditionally, training is administered in a passive way by having employees attend lecture-based training sessions or by asking them to read through procedures.[5] The predominate use of these specific training methods suggests that although the industry is aware of the content safety training needs to cover, they are often unaware of the most effective techniques to deliver this content, especially within the context of how adults learn.[4]

Andragogy, the prevailing theory of adult learning developed by Munoz and Munoz in 1999, indicates that adults require problem-centered learning that encourages learners to use past experiences rather than training that is focused on simply delivering content.[4] Additionally, adult learning processes must be collaborative. Adults learn best through experiential processes that are mutually shared between the learner and the instructor, not the traditional "transmittal and absorption" methods often used in industry."[4,5]

Case Studies

A form of training which effectively utilizes the andragogy learning theory is the case study.[5] Case studies are known to be a highly effective way to teach critical safety information by using scenarios based on real-life situations related to the employee's responsibilities.[5] As discussed above, adult learning is enhanced when new skills are applied in a situation that is relatable to their past experiences and does not just rely on passive transfer of information.[4] Case studies also have the advantage of presenting information in an engaging and dramatic way that grabs and holds trainees' interest and attention.[6] Case studies are akin to a puzzle that must be analyzed and solved. This provides learners with a challenge requiring active, critical thinking rather than the passive conveyance of information which only requires learners to sit and listen.[6] Additionally, case studies deal with practical, real-life problems that employees may actually confront on the job; therefore, skills acquired though case study training are easily transferred to real-life situations in the future. By actively practicing new concepts in

a classroom environment, learners are able to think through a situation and determine how they can best apply what they are actively learning to solve the situation in a lower-stake scenario than on an actual jobsite. Furthermore, although specific hazards presented may be simulated in the training scenario, the concepts of hazard recognition and mitigation are easily generalized to apply to other safety issues in the workplace. Another advantage of case study training is that although case studies provide for more in-depth and effective training, they are usually condensed enough to easily fit into an average-length training session.[5]

Developing a Case Study: Lessons Learned

There are many things to consider when creating a case study to use for safety training. During the development and pilot test of the case studies established by Central Washington University (CWU) students for the AIST Don B. Daily Safety Grant, several lessons regarding effective case study development were learned.

The primary goal of any case study–based safety training should be to facilitate the transfer of the evaluation, problem-solving and decision-making skills learned during the case study process to real-world situations on the job. Therefore, to begin it is imperative to understand the scope of the work being performed, the hazards inherent in the work, and the skills which will be required to recognize and control for those hazards. To this end, it is important to have people who work frequently in the field and face these hazards regularly involved in the development of the training. Employees having a firm grasp of the scope of operations, labor, materials and equipment being used, and any other parameters that might affect safety should be included. When identifying hazards to include in the study, the severity of those hazards, as well as the likelihood of occurrence, should also be considered. This allows for the case study to be as realistic as possible. CWU utilized several mentors in the steel manufacturing industry and toured a facility in order to ensure that the case studies met these goals.

Another recommendation is that case studies have a structure that is methodical and sequential in order. This will allow the trainer to focus on facilitating learner's identification and mitigation of hazards without needing to focus on the procedural administration of the case study itself. In the case studies developed by CWU students for the AIST research grant, the case study was structured to begin with the background of the scenario, followed by prompting questions about potential safety issues in order to elicit recommendations that could be used to improve environmental health and safety at the facility.

The students from Central Washington University who developed the case studies.

Furthermore, it is important to consider how the format and layout of the case study presented to the learners can influence the effectiveness of the training. During the pilot tests of the case studies, it was found that many of the answers to the questions that were meant to be open-ended to allow for expansive and exploratory answers elicited short answers with very little detail. This was attributed partly to the layout used for the case studies being too small for lengthy in-depth answers and explanations, which inhibited the student's likelihood to engage with the material. Therefore, ensuring that the formatting the layout of the studies allows for space for complex answers and indicates to the learner that a more in-depth answer is desired is recommended. An additional way to ensure that the learning goals of case study–based training are met is to present learners with a clearly defined goal for the outcome of the case study to guide their answers.

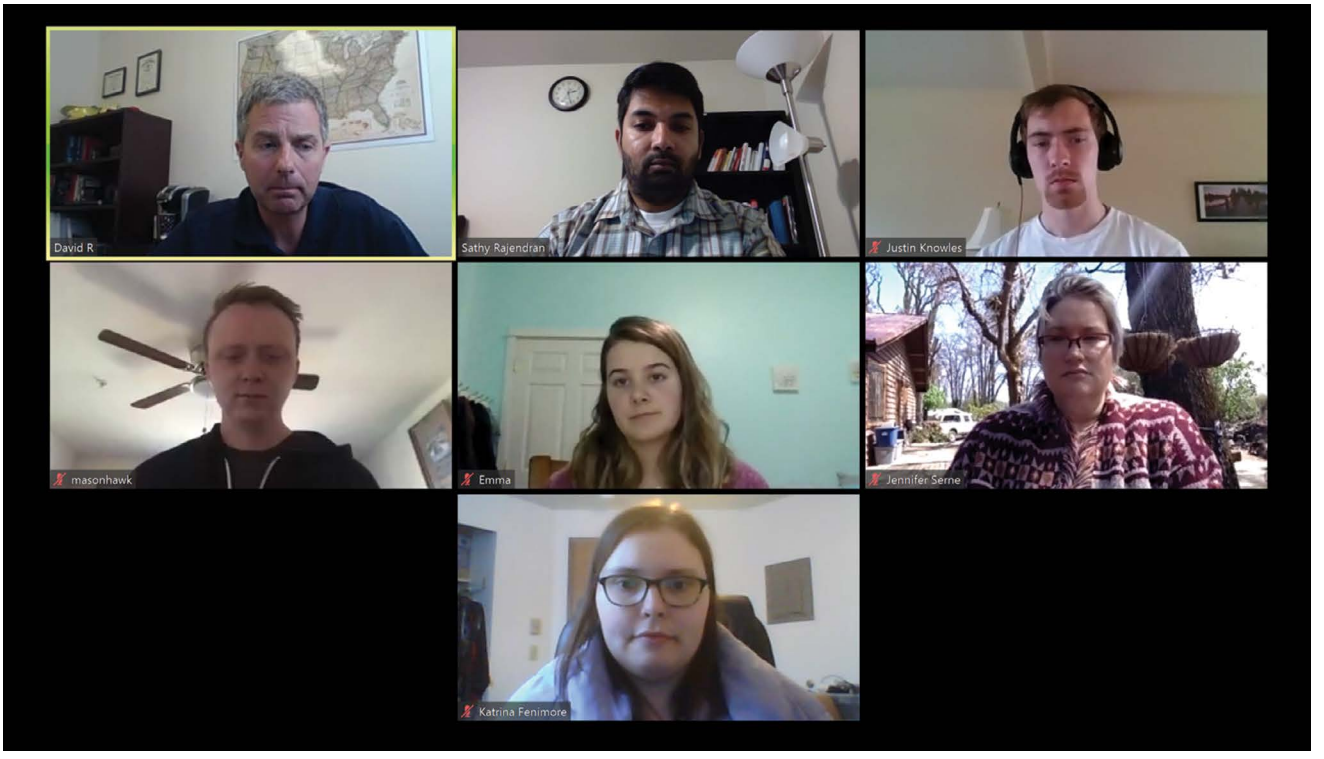
Encouraging interaction between trainers and learners and amongst learners while stimulating trainees to think and solve problems by examining information, considering alternatives, and deciding the safest course of action are important goals when using case study training. One important consideration in regard to these goals is the amount of background information to provide to learners. For example, although the pilot test indicated that the case studies had enough information to provoke critical thinking regarding hazard recognition, and recommendations for controls that could be used to make the jobsite safer, learners often asked for more

specific background information, including specific company policies. The student-developed case studies were purposely missing specific policies and some background information in hopes that this would force students to more fully engage with the material in order to fill in the blanks or prompt more active discussion. It was assumed that this process would not only facilitate active discussion within the groups of learners but also allow for interaction with the instructor through the request for more information via clarifying questions. However, the assumption that students would readily ask questions of their instructors or peers was not always correct; therefore, steps should be taken to encourage this dynamic. This could be accomplished by ensuring that learners understand the process is collaborative, and not an individual assignment. Additionally, providing a clear avenue for questions and discussion of the topic with the instructor will allow instructors to use follow-up questions from students to steer students toward the level of critical thinking needed to meet the goals of the case study–based training. Although it is recommended that instructors have access to more information such as procedures available, questions to the instructor should not just result in learners being passively given information. In order to force students to engage with additional information, instructors should have students reflect on why they are asking for further information, which will allow students to participate more and gain a deeper understanding of the material. Providing too much information to the learners negates the effectiveness of the training. Part of what makes case study–based training effective is that the student gets to interact with the material in a way that realistically compares to real-world operations. In this way, students must still be responsible for collecting information, deciding what is important and determining the best course of action. Therefore, instructors should balance offering enough clarification to learners without outright giving answers.

Sample Case Study: Furnace Room/Metal Melting Process

The following is a case study developed by the students at Central Washington University.

Background — Once the metal has been sorted and the desired mix of materials has been collected into the transfer hopper (charge bucket), it is moved to the furnace room where an electric arc furnace melts the metal. Once the hopper is moved to the furnace room, it is poured into the furnace. The lid is closed and graphite-tipped electrodes are inserted into the furnace to heat the scrap metal to melting temperature.



The Central Washington University team meeting over a Zoom call.

This process burns off many contaminants and causes smoke, explosions and bursts of fire from the furnace. During this process employees are present in the furnace room operating equipment, taking metal samples and checking equipment for damage. Employees are required to wear full face respirators, full body protective clothing and double hearing protection (earplugs and earmuffs) while in the furnace room. Employees also carry radios in order to maintain communication with the control booth that operates the furnace. While the metal is being poured into the furnace, workers on the floor are required to move to designated safe areas to avoid the heat and flying particles that the furnace may create while the materials are being poured in and heated.

Questions

1. What are the primary hazards in the scenario?
2. How would you control the hazards?
3. What role does communication play in the safety of employees working on the floor?
4. If the communications systems were to fail, would operation be able to continue? Why?
5. If a worker were to find compromised equipment while on the floor, why would radio communication systems be utilized to ensure the most efficient emergency response possible?
6. In the primary steel manufacturing industry, burn injuries occur less often than injuries from slips trips and falls, or struck by heavy machinery. Does this change your list of primary safety hazards?
7. Should employees be present on the furnace floor during melting operations? Why or why not?

Recommendations/Suggestions

Importance of Communication: Communication is often undervalued. In this environment, working employees utilize both radios and external earbuds in order to hear the radio while wearing earplugs and earmuffs. This allows for communication during emergency situations where time is critical to safety. Compromised equipment, molten slag fires and injuries have the best outcomes when they can be responded to as soon as possible.

Inherently Hazardous Work: When working with a hazardous process like melting metal, it is important to recognize that even when work is done as safely as possible, the process is still very hazardous. In these cases, complacency can be very dangerous. Vigilance and routine inspections are vital to combat complacency. Additionally, because dangerous conditions can develop quickly without worker awareness, routine safety inspections of equipment during work are very important. These routine inspections are performed with the equipment operating, and are different from inspections of equipment that require lockout/tagout procedures; however, these types of more in-depth inspections should also be performed regularly.

Emergency Response: There is more to emergency response than just communication. Having a well-written plan that everyone knows and having regular training on the plan can ensure that people won't hesitate during an emergency situation. In emergency situations, people may panic or freeze if they are uncertain of what actions to take. Regular training exercises using mock events can reduce this uncertainty and hesitation.

Conclusion

Although a prevailing argument against using case studies in the manufacturing sector is that processes are often changed to meet the needs of production, which makes uniform case studies unrealistic, the ability of case study–based training to enhance the understanding of unsafe acts and conditions can be applied to all processes and procedures. Case studies allow workers to apply these concepts in a controlled environment before they are encountered in the field. Having workers who are trained to think critically about circumstances that stray from the norm before they encounter these pressures in an environment of rapidly changing conditions increases an organization's ability to respond to dangerous situations and mitigates potential damages.

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