Simulation-Based Electrical Safety Training: An Innovation in Safety Culture

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Abstract - An organization's safety culture is marked by shared responsibility, mutual respect, and collective understanding of safety practices and incident prevention. Effective safety training is instrumental in creating the foundation on which to build a safety culture and encourage best practices. Simulation-based electrical safety training presents dangerous realities safely, by connecting workers with hands-on cause-and-effect learning experiences that would otherwise first be encountered on the job.

Simulation-based electrical safety training goes beyond teaching concepts and definitions by providing a virtual environment for interaction, practice, and immediate application of information. In this way it reinforces roles and attitudes, contextualizes information, and serves as a content-rich foundation for a safety culture. This type of training has been used for decades by high-efficiency organizations because they understand that only a fraction of learning effectiveness comes from completing lower-level tasks, such as recalling terminology and procedures. The complex application of concepts is achieved through personalized experiences and unconstrained decision-making with realistic consequences.

Safety training is an important bottom line for any safety culture, and simulation-based electrical safety training offers trainees a robust, personalized experience that engages and empowers them far beyond the classroom.

Index Terms — safety, safety training, safety culture, simulation, learning, retention, computer, education

I. INTRODUCTION

Technology has consistently been propelled by the human desire to increase efficiency and manage knowledge, while simultaneously achieving a deeper personal understanding of our surroundings. Whether learning through books, diagrams, videos, or interaction, humans have capitalized on our natural tendency to organize and apply information in a way that enables us to better understand it. In recent years it has become common to use presentations, hands-on demos and e-learning as a means to facilitate the mastery of skills. Simulation-based safety training similarly explores content as it pertains to an individual's role, but is the only available training that can be designed to implicitly reinforce the individual's relationship to their work environment. This breakthrough technology enables individual retention to become group retention, defining and shaping a safety culture that affects company-wide change in addition to enhancing individual performance.

II. SIMULATION-BASED TRAINING

Advances in technology propel learning strategies by immersing learners in new perspectives and giving them new ways to absorb information for specific applications. The most primitive form of learning is imitation, which is effective but dangerous because of its basis in trial and error and weakness in perpetuating bad habits. Early technology enabled learning through text and illustration, but this practice does not provide satisfactory hands-on experience. Static representations have recently become dynamic and interactive through the use of computer-based simulations, which allow people to return to a hands-on learning process but with reduced risk. For the purposes of this analysis, simulation-based training refers to a learning experience delivered through a personal computer that presents relevant content in an emulated environment and uses goal-oriented tasks and familiar work tools to facilitate safe exploration of complex, and often hazardous, cause-and-effect relationships. This type of training is especially important in the field of electrical safety because of the tragedy that can result when knowledge is not properly applied. Simulation-based training increases knowledge retention while reducing the potential for hazards, because it aligns with critical learning objectives that have been proven to effectively fulfill the ultimate goal of learning – to enable knowledge transfer to real world experiences.

A. *Knowledge Transfer: The desired result of training, facilitated through simulations*

The goal of education is primarily to give the learner skills that will enable them to apply knowledge to new situations. Electrical safety training is no different, and requires increased diligence because of the dangers associated with electrical work. For the purposes of this analysis, rote recall of learned processes and procedures will not be addressed; rather, attention will focus on the informed application of learned concepts delivered through the mechanism of simulation. The real-world application of these concepts is referred to as *knowledge transfer*, and is an integral part of a unified safety culture. Simulations enable learners to

internalize concepts but also to understand them in a larger context, cultivating an appreciation for individuals and systems that exist outside of the learner's direct experience.

One requirement for successful knowledge transfer is the learner's ability to think critically about the application of concepts. Schwartz & Heiser [6, p.4] have determined that people interacting with objects in a simulation develop a capacity for "pre-interpretation", meaning that they conceptualize objects interacting before they engage them in motion. Simulation-based training is composed of a series of "what if" decisions that condition learners to pre-interpret a variety of relationships, creating a habit of awareness that transforms the way learners evaluate situations, including those in the real world.

Research supports that knowledge transfer requires not only skill comprehension, but additionally "a scenario of declarative knowledge relating these skills to the goal" [2, p.135]. Simulations can be designed to incorporate this multi-layered approach to presenting information, by simultaneously offering multiple objectives that contribute to a broad, domain-specific system. The learner actively participates in the analysis of objectives and begins to think more deeply about the relevance and relationships of concepts. This evaluation process is constant within a simulation because of the variety of potential results, which are dependent on the choices of the individual. Dynamic decision-making gives learners ownership of information, enabling them to internalize what they have learned and giving them confidence to apply that knowledge to real-world situations.

B. *Situated Learning: Teaching concepts in a meaningful context*

In order to maximize knowledge transfer, training must support a "variety of cognitive, emotional, and social aspects of learning…" [5, p.12], giving the learner information while at the same time cultivating the ability to think critically and to dynamically apply concepts socially and emotionally. The very nature of simulations positions cognitive information in a context that incorporates the skills, environment, goal and tools necessary to complete a task. This idea, that learning is not separate from the activity or its context, is referred to as *situated cognition*, and is arguably the most effective contributor to knowledge transfer. When learners engage simulations that are designed to present specific industries and replicate familiar environments, trainees receive a structured training experience that naturally applies to their work environment and is equally relatable to each learner from his own perspective.

In addition to contextualizing information and objectives, simulations also contextualize the outcomes of learners' decisions. They deliver real-time feedback on two levels; the first gives localized feedback based on a specific choice, while the second level iteratively alters the environment to align with the complete series of choices the learner has made. This characteristic of simulation-based training emulates the complexity of real life decision-making, preparing trainees to meet the real challenges of the workplace.

Situated cognition becomes even more powerful when simulations employ a "multi-player" structure that enables learners to interact with one another in a virtual space. The benefits of simulation technology are at the core of the experience, but social relationships are now part of the learning structure. Individuals and groups now interact with one another, directly affecting each other's cognitive, emotional and social experience. Simulations can aid in reinforcing the hierarchy of relationships within organizations while safely demonstrating the impact of the learner on more complex systems.

Each layer of complex interaction and response provided by simulation-based training uses multi-sensory output, combining compelling sound and visuals to illicit an emotional response from the learner. For example, trainees can understand arc flash calculations that are performed on paper, but the learning experience pales in comparison to triggering an arc flash incident oneself, being startled by the sound of the explosion and watching a realistic scenario unfold onscreen.

C. *Behavior Change: The quantifiable goal of training and evidence of cultural shift*

Simulations enable learners to increase knowledge and improve perspective, but the results of this understanding reach far beyond individual experience. Using simulation-based training technology also enables whole organizations to solidify concepts and practices in a way that can facilitate behavior change, and reinforce a long-term cultural commitment to core values.

Much of an organization's collective knowledge resides within the experience of individuals, but studies have concluded that knowledge also becomes embedded in an organization's tools and technology, as well as in its networks within an organization [1, p.154]. Simulations enable organizations to standardize content for each successive training group while engaging individual learners on a deeper, more personal level. The knowledge imparted by simulations pervades an organization more effectively than traditional training, which has the potential to be inconsistent in both content and delivery.

For decades, high-efficiency organizations such as the medical community, military, and large corporations, have seen the value of simulation-based training and have employed this approach. In recent years large corporations in the technology and food service industries have also used simulation-based training to teach repair processes, optimize their work force, and to emulate customer experiences in order to improve customer relations.

These companies use simulations to teach and reinforce elements of company culture that were lacking, and observed positive effects. One technology company used simulations to improve repair speed and performance, and noted that employees who trained with the simulation scored 5% - 8% higher on the training assessment than those who learned using traditional training methods [7, p.2]. A high-tech Fortune 500 company wanted staff to focus on resolving persistent

customer dissatisfaction. Upon completing a simulation that emulated experiences described by customers, the company experienced a cultural revolution as employee focus changed dramatically and the company began receiving service excellence awards from previously dissatisfied customers [3].

II. CONCLUSION

Simulation-based safety training has real merit in teaching both individual skills and the holistic application of knowledge across organizations. Its benefits reach far beyond linear understanding by focusing on complex processes and applications of concepts that readily translate into real-world behaviors. Utilizing this type of training in a safety program only serves to deepen knowledge and solidify the core values of an organization.

There is evidence to suggest that although simulation-based training is effective, it often must be adapted to the context of the recipient site [1, p.157]. This presents a challenge both to organizations and simulation developers to remain open-minded and to work with one another when considering and implementing a simulation-based training solution. A similar concern, presented by Sitzmann & Ely, [7, p.8], is that simulation-based instruction is rarely well-designed enough to be the sole instructional tool in a curriculum. This matter is of particular importance to the discipline of safety training, and increases the need for communication between organizations and simulation developers.

III. REFERENCES

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VI. VITA

Eben Myers, Vice President of Production at Etcetera Edutainment, has done both theoretical research and hands-on design and production of games, simulations, and related systems for many companies and organizations, including Kodak, Electronic Arts, and NASA. He has published and presented work on videogames, artificial intelligence, educational interfaces, robotic exploration, and augmented reality. Eben holds a B.A. from Swarthmore College and a Master’s Degree in Entertainment Technology from Carnegie Mellon University.

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