The Value of VR Training for Today's Shotcrete Nozzlemen

By Matthew Wallace

Recruiting, training, and retaining skilled shotcrete nozzlemen is mission-critical for a company's success. Virtual, immersive training offers an effective, engaging mode of learning that supports the modern trainee. For beginning nozzlemen, virtual reality training gives them a safe, repeatable experience that can be completed in a classroom, free of job costs. Practice without cost or risk also helps improve job performance and satisfaction. These disruptive virtual reality (VR) technologies can provide safe, hands-on learning experiences without the field costs associated with hands-on training. Virtual learning is also valuable in today's socially distanced world with its shifting remote learning requirements. Interactive digital tools will deliver meaningful, adaptive training for skilled trades now and in the future. Though some level of hand nozzling experience is still needed the best nozzlemen will be trained, in part, using virtual reality.

Blending virtual reality with traditional learning is a great option because it combines the best of "tried and true" education methods with innovative and engaging training experiences. While cost-effective, textbooks and manuals fail to teach the nuance and awareness required for complex, hands-on skills. Replacing dull and unimaginative text with immersive learning creates high-retention experiences that engage the trainee both physically and mentally. Learning becomes practical, experiential, and immediate. Virtual training methods fuse the benefits of simulated hands-on, apprenticeship-style training with the traditional pedagogy available in printed training resources. This blended learning approach merges the best parts of traditional training methods with effective, experiential learning.

Virtual reality is a more engaging option because it uses technology to enhance training insights and functions in real-world contexts. Virtual and augmented reality (or mixed reality) provide experiences that make learning visual, interactive, and compelling. The technology enhances a training program's ability to expose trainees to practical challenges in a consequence-free environment. Virtual training is an accessible and practical alternative when working with real-life situations could be expensive, wasteful, or dangerous. Nozzlemen can practice on a virtual model of the next project without cost or consequence. Furthermore, trainers will be able to analyze trainee performance with objective data showing performance time and quality. The new data provides instructors insights for tracking student progress and points out specific skills deficiencies of the individual trainee. The instructor can then provide specific lessons and cues to remedy the trainee's performance.

Other industries have used virtual training for precision skills training. In manual arc-welding, Lincoln Electric's VRTEX® provides a virtual training experience for trainees with instant and aggressive feedback on their weld performance (Fig. 1). Trainees learn how to set up a welding machine, adjust gas flows, strike an arc, and construct and manipulate a weld puddle to create a quality weld. The virtual experiences develop a cognitive link between torch movement, body position, and correct machine settings. The student learns what to do and what it feels like fusing their practical knowledge with effective torch manipulation and body positioning. The trainee learns by doing, with virtual reality enhancing, every facet of a trainee's practice.

But, can virtual reality train a better welder? Research confirms that this fusion of practical and pedagogical knowledge works. A 2013 University of Iowa study[1] compared a blended training approach (50% virtual and 50% traditional) with traditional training methods. Each student completed weld projects, developed muscle memory, and learned how to create correct welds. As expected, in simulation-based activities, the blended training students consumed fewer raw materials. At the study's conclusion, all the students went into the weld booth and made test welds. These welds were then sent to certified welding inspectors for review. The certification rates for the VR students surpassed those of their traditionally trained counterparts by more than 40 percent, and they showed a greater proficiency with more difficult welds. The study also pointed out an unexpected side benefit of the VR approach. The students all showed an increased rate of collaborative learning and open communication. The VR trainees achieved a deeper understanding of the welding processes and a stronger ability to convey that understanding to their instructors.

Similar results can be found in painting and sandblasting. VRSim's SimSpray® is a virtual reality spray paint and blasting training system (Fig. 2). Through SimSpray, coatings professionals gain hands-on experience and develop transferable skills that prepare them for real-world projects. Custom lessons provide paint trainers and trainees with feedback and visual cues that aid students in learning how to paint walls or sandblast bridge components (Fig. 3). Students receive feedback including the depth of coverage or known defects caused by failures in their technique.

Fig 1 - VRTEX VR Welding Training

Would virtual training work for shotcrete? The techniques required for high-velocity spraying of concrete has characteristics in common with abrasive blasting and painting. Nozzlemen must know the basic formwork for the underlying shotcrete structure, how to manage their equipment and material mix, and the proper application techniques. Traditional training methods include basic theory and principles but rely on hands-on experiences to teach nozzlemen-in-training. Virtual training can help nozzlemen gain basic skills faster and better.

Virtual training could supplement current training with engaging and interactive experiential challenges. Nozzlemen can learn by doing in a safe virtual environment, reducing waste and gaining technique. Virtual systems will provide objective feedback. With a standardized rating system in place, trainers can set consistent benchmark standards for progression and differentiate the adequate from the exceptional. Using the virtual environment affords trainers the opportunity to augment training with cues to guide performance and provide analysis tools that assess a trainee's progress. Performance scores will assess everything from the trainee's speed, distance, and angle, to their time on the project and the amount of material used to complete it.

VR training tools would offer a safer learning experience and minimize the potential negative impact on job quality from on the job training. With such a high-velocity material application, poor application form and low equipment awareness can create dangerous worksite conditions. Teaching these principles in virtual environments mitigates the risk of teaching them on a live worksite, leading to improved on-site performance and less rework. These components combined will improve the skills of nozzlemen throughout the industry, improving quality and making worksites safer.

Fig. 2 - Sim Spray - Coating VR Training

VR training is more than a simulation; it's a training tool for trainees and trainers alike. Immersive, problem-based training methods create opportunities that leverage natural learning experiences and foster improved team communication skills. Projects set clear goals and challenge trainees with realistic work while the immersive and experiential nature of the tasks promotes sharing tips and discussing challenges. As trainees progress through projects, they work independently and collaboratively to overcome skill gaps. Trainees are given accessible and repeatable learning experiences for their core job skills and to improve the soft skills that create strong teams. Furthermore, training creates competition among students, reinforcing a trainee's competitive drive to excel. Performance scores mark individual progress while setting a bar for the next trainee to surpass. The same psychology that gets people to brag about their high scores can motivate trainees to practice. Guided repetition is the mother of skills expertise.

Trainers are empowered by the VR training tool's capacity to reduce their more tedious tasks and inform them with performance data. For trainers, the use of simulations with objective scoring creates more trainee engagement and tracks skills development. The trainers will diagnose student strengths and weaknesses and be able to supplement trainee curricula to strengthen the related skills. Realistic scoring systems grade project performance and allow graduated and adaptable learning progressions.

Training managers can make clearer decisions through objective performance data. The ability to evaluate trainee skills with measurable comparison data provides insight into the performance of an individual student and creates a quantifiable demonstration of the effectiveness of the enterprise's training efforts. This information affords the manager and organization the ability to make informed, data-driven decisions about teams and training programs.

Disruptive technologies may be easy to use, but they require programmatic implementations to realize their full potential. For them to be effective, the organization must commit to incorporating virtual training into its curriculum.

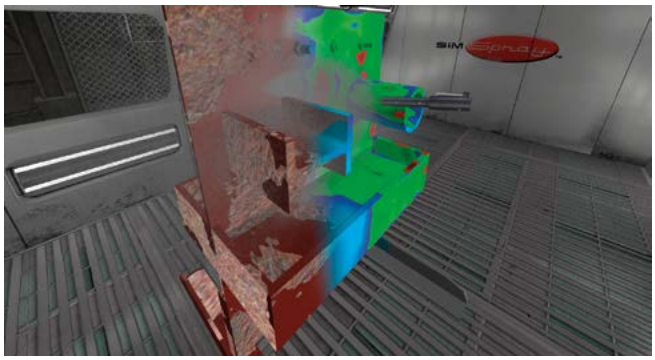

Fig. 3 - Visual feedback during VR training

Putting disruptive technologies like virtual training into practice requires consideration and planning. While cost is a consideration, the company must invest in systemic change, accepting the costs of adapting to a new way of thinking and a new way of training. Training the trainers is essential.

With a rapidly changing workforce, there is no more effective, or efficient way to train. The best shotcrete nozzlemen of tomorrow will have learned the basics of their job using virtual reality to supplement their classroom learning.

1. Stone, Richard T.; McLaurin, Elease; Zhong, Peihan; and Watts, Kristopher Patrick. (2013). Full Virtual Reality vs. Integrated Virtual Reality Training in Welding.

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