

**Aligning with Industry: Using Virtual Reality Technology to Provide Psychomotor Skill
Development and Assessment in a Post-secondary Setting**

Trent Wells
Iowa State University
223C Curtiss Hall
Ames, IA 50011
ktw0004@iastate.edu

A. Preston Byrd
Clemson University
253 McAdams Hall
Clemson, SC 29634
apbyrd@clemson.edu

Ryan Anderson
Sauk Valley Community College
173 Illinois Route 2
Dixon, IL 61021
ryan.g.anderson@svcc.edu
WorkUsed

Aligning with Industry: Using Virtual Reality Technology to Provide Psychomotor Skill Development and Assessment in a Post-secondary Setting

Introduction

Workforce development remains a key issue within the agricultural industry as an entity (Roberts, Harder, & Brashears, 2016). As part of the solution to these issues, agricultural education serves as a vehicle to provide, through a variety of methods, human resource-related solutions for individuals and industry (Roberts et al., 2016). In recent years, one particular focus of agricultural education, broadly defined, has been an increased emphasis on the use of science, technology, engineering, and mathematics (STEM) principles to help solve the problems of today and tomorrow (Roberts et al., 2016). As such, it is conceivable that these concepts (i.e., technology) could lend themselves to solving human capital issues as well.

As a discipline, advanced technologies are increasingly present within all aspects of agriculture, including education (Roberts et al., 2016). Various technologies are available for use within agricultural education settings (Phipps, Osborne, Dyer, & Ball, 2008). As applied to the teaching and learning process, these technologies can potentially include differing types of applications, such as computer-based games, interactive software, virtual reality (VR) technology, and more (Phipps et al., 2008). Regarding VR technology, a variety of simulator-based systems exist that have been designed for multiple venues, including psychological testing, medical science, and welding education (Ahlberg et al., 2002; Muhlberger, Herrmann, Wiedemann, Ellgring, & Pauli, 2001; Stone, Watts, & Zhong, 2011). Many of these systems have focused primarily on psychomotor skill development, with primary purposes being to reduce and, if possible, eliminate errors during live work and to minimize expenses related to consumable materials (Byrd, 2014). Several studies (Stone et al., 2011; Stone, Watts, Zhong, & Wei, 2011; Stone, McLaurin, Zhong, & Watts, 2013) suggest that using VR technology could be beneficial to student achievement and skill acquisition. Perhaps an alignment with industry-based workforce development practices through the integration of VR technology into a skills-based agricultural mechanics course at Iowa State University (ISU) could serve a similar purpose.

How it Works

The American Welding Society (AWS) has developed comprehensive weld standards to ensure a level of consistency within the metal fabrication industry (AWS, 2017). To aid in developing welding-related psychomotor skills that meet such standards, the course instructor, per the suggestions of Byrd and Anderson (2011) and Clark (2011), elected to utilize the Lincoln Electric VRTEX® 360 VR welding system, which was designed to provide individualized instruction, practice, and immediate feedback related to welding position, travel speed, work angle, and so forth, all within a realistic, virtual environment. Four different weld joint and position types (e.g., 1G, 3G, 2F, and 3F) were selected to be used during the shielded metal arc welding (SMAW) and gas metal arc welding (GMAW) portions of the course. In total, eight different welds were to be performed. All seven of the students were required to practice each of the welds for a minimum of 30 minutes, allowing adequate time to experiment with and develop comfort with using the VRTEX® 360. This 30-minute time period also allowed students to attempt as many practice welds as possible before rotating out to allow others to practice.

The VRTEX® 360 provides numerical scores for welds on parameters such as welding position, work angle, travel angle, travel speed, and contact to work distance/arc length, as well as an overall score for the individual weld. For establishing consistency in psychomotor skill development, as well as for assignment evaluation purposes, students were required to produce at least two consecutive overall weld scores of 80 before a score would be acceptable as an assignment grade, with the highest weld score being designated as the official grade for the weld. These practices have been consistently used within industry to train and assess welding skills, thus allowing for an alignment between the educational and industrial sectors. A score of 80 is used by Vermeer Corporation, an AWS-designated outstanding industry-based training program as the minimum permissible score prior to entering into the physical portion of the training program. Due to course meeting time limitations, students were permitted to practice during and outside of the normal course meeting time, pending instructor approval. Students were allowed to choose the sequencing of the welds for practice, though most chose to follow the designated progression of the course (i.e., SMAW to GMAW) and that students were permitted to work ahead in using the VRTEX® 360 as scheduling allowed.

Implications

The use of the VRTEX® 360 to provide industry-aligned psychomotor development and assessment appeared to be an effective training method, as also found by Byrd (2014). The typical student, anecdotally, had very little experience in welding, and many remarks were made that the use of this training method helped to identify and correct procedural errors quickly, efficiently, and effectively. Moreover, the course instructor noted that student engagement was high and there was considerable excitement about using this technology. Based upon instructor observations during the welding exercises, it is conceivable that the sequencing of training methods (e.g., virtual welding then live welding, or vice versa) could positively alter the psychomotor skill development process. Perhaps further research should address these notations.

Future Plans & Advice to Others

The course instructor intends to continue this process in future course offerings, perhaps even expanding into other agricultural mechanics coursework at ISU. A potential alteration to this training regimen may include shortening the time that students are required to dedicate to each weld may assist with time management and equipment availability issues, as fall and spring semester offerings of the course typically are composed of 18 students. Also, greater adherence to following the weld training sequencing of the course (i.e., SMAW to GMAW) while using the VRTEX® 360 could help to maintain focus on each welding process.

Costs

The primary costs of implementing these procedures were related to the acquisition of a Lincoln Electric VRTEX® 360. The unit cost approximately \$55,000.00 and was funded by a computer technology fee grant. The only other cost to operate the VRTEX® 360 was the consumption of electricity, which was similar in quantity to a personal computer's usage. Cost savings were noted through the reduction of consumables typically used during the weld process, as well as greater efficiency in improving psychomotor skill development.

References

- Ahlberg, G., Heikkinen, T., Iselius, L., Leijonmarck, C. E., Rutqvist, J., & Arvidsson, D. (2002). Does training in a virtual reality simulator improve surgical performance? *Surgical Endoscopy and Other Interventional Techniques*, 16(1), 126-129. doi: 10.1007/s00464-001-9025-6
- American Welding Society. (2017). *Standards*. Retrieved from <http://www.aws.org/standards/>
- Byrd, A. P. (2014). *Identifying the effects of human factors and training methods on a weld training program*. Retrieved from Iowa State University Digital Repository Graduate Theses and Dissertations. (Paper 13991)
- Byrd, A. P., & Anderson, R. G. (2011). Green welding...utilizing the VRTEX 360 to reduce our carbon footprint. *Proceedings from the 2011 North Central Region Conference of the American Association for Agricultural Education, Innovative Idea Poster Session*. University Park, PA: 75-77.
- Clark, M. S. (2011). Virtual reality arc welding: Training the digital native. *Proceedings from the 2011 American Association for Agricultural Education National Conference, Innovative Idea Poster Session*. Coeur d'Alene, ID: 201-204.
- Muhlberger, A., Herrmann, M. J., Wiedemann, G., Ellgring, H., & Pauli, P. (2001). Repeated exposure of flight phobics to flights in virtual reality. *Behaviour Research and Therapy*, 39(9), 1033-1050. doi: 10.1016/S0005-7967(00)00076-0
- Phipps, L. J., Osborne, E. W., Dyer, J. E., & Ball, A. (2008). *Handbook on agricultural education in public schools* (6th ed.). Clifton Park, NY: Thomson Delmar Learning.
- Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). (2016). American Association for Agricultural Education national research agenda: 2016-2020. Gainesville, FL: Department of Agricultural Education and Communication.
- Stone, R. T., Watts, K., & Zhong, P. (2011). Virtual reality integrated welder training. *Welding Journal*, 90(7), 136-141. Retrieved from http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1042&context=imse_pubs
- Stone, R. T., Watts, K. P., Zhong, P., & Wei, C. (2011). Physical and cognitive effects of virtual reality integrated training. *Human Factors*, 53(5), 558-572. doi: 10.1177/0012720811413389
- Stone, R. T., McLaurin, E., Zhong, P., & Watts, K. (2013). Full virtual reality vs. integrated virtual reality training in welding. *Welding Journal*, 92(6), 167-174. Retrieved from http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1041&context=imse_pubs