Teaching Tips/Notes NACTA Journal

Can Dexterity Predict Future Performance of Novice Welders?

Introduction

Within industrial manufacturing a global boom has occurred increasing the demand for skilled laborers, specifically welders (Brat, 2006). Between 2010 and 2020 the need for welders was predicted to increase 15% (U.S. Department of Labor, Bureau of Labor Statistics, 2012). Welding requires practitioners to become certified, which is costly and time consuming (Stone et al., 2011). The time required to train certified welders is one of the obstacles training programs face. Many companies have expressed that many students often fail after extensive training (Hitchings and Moore, 1991). Giachino and Weeks (1985) posited that to master the craft of welding could take years of on-the-job training. These concerns have made the welding industry examine how welding training programs recruit individuals to become certified welders. One source of potential workers are graduates of agricultural education programs, but Rivera (2008) indicated one problem that educators face is producing competent graduates to take up available job positions in agriculture.

Since the inception of welding, training programs have continued to get better at preparing welders. Welding instructors/trainers have incorporated several computer-based advancements into the training programs such as virtual reality simulations (Byrd and Anderson, 2012). The use of virtual reality has shown advantages in increasing the number of students that become certified and reducing the required training time for less complex welds (Stone et al., 2013). The uses of virtual reality welding simulators have also motivated people to try hands-on welding processes (Postlethwaite, 2012). With an influx of newcomers (Postlethwaite, 2012) that want to try welding is there a way to predict which individuals will have the capability to be successful in a welding program?

Several occupational fields have tried to predict an individual's ability of future performance prior to admitting them into a training program. The tests that have been utilized to predict future performance include analyzing cognitive ability, psychomotor skills, and perceptual tests (Brown and Ghiselli, 1951; Gettman et al., 2003; Hitchings and Moore, 1991; Levine et al., 1996). A study by Gettman et al. (2003) shown that the measures of innate ability were able to accurately predict the future performance of 65% of laparoscopic surgeons (n = 20). Welding literature suggests that welders need manual dexterity, good eyesight, and good hand-eye coordination (Giachino and Weeks, 1985). If a dexterity test that replicates the psychomotor skills necessary for welding is implemented in a training program, will it be able to accurately predict the future performance of the students? If the predictive ability exists, would it give agricultural educators the capability to help guide those students who have an interest in welding to the most appropriate jobs within the industry?

How it Works

To examine if dexterity can be used to predict the future performance in an individual to weld several steps must be taken. First, choosing the correct dexterity test that replicates the dexterous abilities that a welder must have is crucial. One dexterity test that closely resembles a welder's dexterity and evaluates dexterous ability is the Complete Minnesota Dexterity Test (CMDT). Gross motor skills, rapid hand-eye and arm-hand coordination is measured by the CMDT (Lafayette Instrument, 2012). The CMDT utilizes two test boards, each containing 60 holes. There are 60 corresponding black and red disks that fit into the holes, which the participants manipulated. The information that needs to be recorded from each test is the time it took to finish the test. For most dexterity tests, the tests will be repeated at least twice in order to get an average score of dexterity.

A welding training program must then evaluate the individuals' dexterous abilities. We recommend administering dexterity tests at various times to examine if a specific time during a training process provides a more accurate indication of future performance. For example, dexterity tests could be completed on the first day of training, after one week, after two weeks, and after weld test plates have been completed. In order to evaluate the effectiveness of dexterity as a future performance indicator, students must complete the welding training program. By completing the welding training program, students will produce weldments that will be submitted for visual inspection by the CWI. The pass/fail information from the visual inspection will be needed. Evaluation of dexterity will be examined by analyzing the recorded times of the dexterity tests and comparing them to the pass/fail information from the destructive tests. Correlational analyses and effect sizes would need to be calculated to evaluate if dexterity could be used to indicate future performance.

Implications

If dexterity can be used to predict future performance in beginning welders this ability would allow the welding industry to select participants that meet this criteria. By employing a selection process for the welding industry, the amount of time, consumables needed, and money required to train beginning welders would be reduced. This in turn would create a more efficient hiring process for the welding industry. This would also aid training program become more efficient in producing certified welders.

Future Plans

Researchers at Iowa State University examined if dexterity can predict future performance in beginning welders. In conjunction with Lincoln Electric and the Industrial Manufacturing and System Engineering department, a weld training research study was conducted in the summer of 2013 that investigated multiple aspects of a welding training program, including the use of CMDT to predict performance. The researchers are waiting for the results of the destructive tests to make final recommendations.

Costs/Resources Needed

It is assumed that the CMDT testing would be integrated into existing welding programs. The only expense would be the purchasing of the CMDT kit, which is approximately $200.

Additionally, stopwatches will be needed to time the students. To reduce the amount of time needed for participants to complete the dexterity test we recommend purchasing or building additional sets.

References

Brat, I. 2006. Where have all the welders gone, as manufacturing and repair boom. The Wall Street Journal Online. http://visiblewelding.com/SourceItems/Wall.Street.Journal.Where%20Have%20All%20the%20Welders%20Gone.pdf.

Brown, C. and E. Ghiselli. 1951. The relationship between the predictive power of aptitude test for trainability and for job proficiency. Journal of Applied Psychology 36(6): 370-372. DOI: 24658879.

Byrd, A.P. and R.G. Anderson. 2012. Integrating virtual reality to reduce anxiety in beginning welders. Proceedings from the poster session of the North-Central Region American Association for Agricultural Education Research Conference. Champaign, IL. 20-23.

Gettman, M., G. Kondraske, O. Traxer, K. Ogan, C. Napper, D. Jones, M. Pearle and J. Cadeddu. 2003. Assessment of basic human performance resources predicts operative performance of laparoscopic surgery. Journal of the American College of Surgeons 197(3): 489-496. DOI: 10.1016/S1072-7515(03)00333-8.

Giachino, J. and W. Weeks. 1985. Welding skills. Alsip, IL: American Technical Publishers, Inc.

Hitchings, G. and M. Moore. 1991. Dexterity and trainability testing. Work Study 40(3): 15-20. DOI: 10.1108/EUM0000000002645.

Lafayette Instrument. 2012. Complete Minnesota dexterity test: Examiner's manual. www.lafayetteinstrument.com.

Levine, E., P. Spector, S. Menon and L. Narayanan. 1996. Validity generalization for cognitive, psychomotor, and perceptual tests for craft jobs in the utility industry. Human Performance 9(1): 1-22. DOI: 10.1207/s15327043hup0901_1.

Postlethwaite, D. 2012. Community college welding program update. Welding Journal 91(4): 33. http://www.lincolnelectric.com/assets/US/EN/literature/mc1253.pdf.

Rivera, W.M. 2008. Three (post-secondary agricultural education and training) challenges and the concept of 'workforce education systems.' Journal of Agricultural Education and Extension 14(1): 53-68. DOI: 10.1080/13892240701820546.

Stone, R., E. McLaurin, P. Zhong and K. Watts. 2013. Full virtual reality vs. integrated virtual reality training in welding. Welding Journal 92(6): 167-s-174-s.

Stone, R., K. Watts and P. Zhong. 2011. Virtual reality integrated welder training. Welding Journal 90: 136-s–141-s. http://www.aws.org/wj/supplement/wj201107_s136.pdf.

U.S. Department of Labor, Bureau of Labor Statistics. 2013. Occupational Outlook Handbook, 2013-2013 ed. http://www.bls.gov/ooh/production/welders-cutters-solderers-and-brazers.htm#tab-6.

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