Accident Analysis and Prevention 48 (2012) 204–213

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Using game technologies to improve the safety of construction plant operations

Hongling Guo [a,b,*], Heng Li [a], Greg Chan [a], Martin Skitmore [c]

[a] Department of Building and Real Estate, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
[b] Department of Construction Management, Tsinghua University, Beijing, China
[c] School of Urban Development, Queensland University of Technology, Gardens Point, Brisbane Q4001, Australia

ARTICLE INFO

Article history:
Received 3 November 2010
Received in revised form 17 May 2011
Accepted 5 June 2011

Keywords:
Construction
Plant
Equipment
Operation
Game technology
Safety training

ABSTRACT

Many accidents occur world-wide in the use of construction plant and equipment, and safety training is considered by many to be one of the best approaches to their prevention. However, current safety training methods/tools are unable to provide trainees with the hands-on practice needed. Game technology-based safety training platforms have the potential to overcome this problem in a virtual environment.

One such platform is described in this paper – its characteristics are analysed and its possible contribution to safety training identified. This is developed and tested by means of a case study involving three major pieces of construction plant, which successfully demonstrates that the platform can improve the process and performance of the safety training involved in their operation. This research not only presents a new and useful solution to the safety training of construction operations, but illustrates the potential use of advanced technologies in solving construction industry problems in general.

1. Introduction

The construction industry is one of the major high-risk industries world-wide (e.g. Behm, 2005; Camino et al., 2008; Niza et al., 2008; Sokas et al., 2009). The accidents that occur include those that result from falling from height, collision, collapse and electric shock, among which falling from height and collisions are the most prevalent (Dong et al., 2009; Schriver and Schoenbaum, 2003; Sokas et al., 2009). Many accidents are caused by the large and heavy plant (e.g. tower cranes, mobile cranes, etc.) commonly used on construction sites. For example, more than 127 crane-related deaths and 253 heavy plant/equipment-related deaths were recorded between 1992 and 2002 in the USA (Beavers et al., 2006; McCann, 2006), with 41 crane-related fatalities in 2006 in Japan (Kawata, 2007), and 14 crane-related fatalities from 1998 to 2005 in Hong Kong (OSHC, 2008a). In addition to the large project costs incurred by these accidents (Laitinen et al., 1999; Siu et al., 2003; Waehrer et al., 2007), many workers lose their lives. Although much legislation relating to occupational safety and health has been instituted in many countries and regions (e.g. USA, UK, Japan, Hong Kong, etc.), there are still considerable safety problems in the construction industry in need of attention (Waehrer et al., 2007).

1.1. Safety training and performance

Inadequate, or lack of, safety training has been identified as an important contributing factor to high accident rates in the construction industry (Abdelhamid and Everett, 2000; Tam and Fung, 2011; Toole, 2002; Tse, 2005). An efficient *safety training* programme, therefore, can improve safety performance through preventing accident occurrence and is regarded as an important and effective method for enhanced occupational safety and health (Abdelhamid and Everett, 2000; Dong et al., 2009; Halperin and McCann, 2004; Lee and Halpin, 2003; Wallen and Mulloy, 2006). *Safety performance*, on the other hand, is mainly influenced by *safety climate* and the *psychological stress* of employees (Barling et al., 2002; Griffin and Neal, 2000; Guastello, 1991; Guastello et al., 1999; Hoffmann and Stetzer, 1996; Jex and Beehr, 1991; Siu et al., 2004).

Safety climate involves *safety attitudes* (Donald and Canter, 1994) and *communication* (Cheyne et al., 1998; Hoffmann and Stetzer, 1998). *Safety attitudes* refer to employees' attitudes to safety (Donald and Canter, 1993) and they reflect the employees' cognition of safety knowledge. *Communication* refers to an "open, free-flowing exchange about safety-related issues" (Hoffmann and Stetzer, 1998). Full cognition of safety and efficient communication can prevent the occurrence of accidents (Hoffmann and Stetzer, 1998) and training provides an opportunity for employees to cognize knowledge related to safety (Topf, 2000), discuss safety issues, and therefore increase safety performance.

In contrast, *psychological stress* is an affective reaction to a job and is caused by dissatisfaction, depression and anxiety (Hoffmann and Stetzer, 1998; Jex and Beehr, 1991). High psychological stress

* Corresponding author. Tel.: +852 2766 5803; fax: +852 3400 3382.
E-mail address: samuel.guo@polyu.edu.hk (H. Guo).

0001-4575/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2011.06.002