Session: G3.0
Title: From Virtual Reality to Reality
Category: Special Session
Organized by Hongwei Hsiao, National Institute for Occupational Safety and Health
Moderator(s): Hongwei Hsiao

G3.1 Virtual Reality for Safe Equipment Operation—Hollands R

AIMS Research at the University of Nottingham is involved in applying the latest computer technology to health and safety related training. Both computer animation and virtual reality (VR) technologies are used for different aspects of training. Computer animations can be used in video or multimedia training tools to demonstrate particular hazardous situations or even reconstruct real accidents. Virtual reality extends the graphic realism of computer animation to allow the trainee to explore and interact in real-time.

It is unfortunate that most people learn their most important lessons by making mistakes; however, in real-life learning, this often results in injury to personnel, damage to equipment, or disruption to production. By allowing these mistakes to be made within a virtual environment the risks are effectively removed, and managing the situations to which the trainee is exposed can result in the equivalent of many years on-the-job training, acquired in a very short time.

AIMS Research has developed a training application development tool called SAFE-VR which allows PC-based VR training applications for hazard spotting, equipment operation etc. to be easily created, without any programming knowledge required.

The benefits from using VR training technologies can be hard to assess numerically, although the literature abounds with anecdotal evidence showing reduced cost of training, reduced downtime of equipment and improved knowledge retention and skill levels. Unfortunately, traditional VR solutions were expensive to both create and maintain, resulting in unfavourable cost/benefit ratios. However, the advance of PC technology and 3D computer games now means that entry-level PCs could easily run simple VR training tools, and it should only be a matter of time before VR becomes as common a training tool as multimedia CD-ROMS are now.

G3.2 Employing Virtual Reality Simulations of Agricultural Tractor Operation for Assessing Safe Behavior Among Youth - A Feasibility Study—Stredney D, Sessanna D, Bryan J, Heaney C, Bean T, Wilkins JR

An integrated system that provides subjects with an immersive, real-time virtual environment for experiencing tractor rollovers has been developed. This system is based on relatively low-cost and portable equipment. The objective of this work has been to assess the feasibility of employing Virtual Reality simulations of farm equipment operation as a method for evaluating the acquisition of safe behavior practices among 13- to 16-year-old youth who participate in the Ohio Tractor and Machinery Certification Program.

Through the integration of stereographic and audio stimuli with haptic (force reflection) interfaces, the prototype system presents a plausible real-time environment for experiencing tractor operation/interaction, including adverse outcomes like rollover. We have developed a functional, dynamic model of the tractor based on a discrete damped spring-mass system that approximates the physical behavior of a tractor and executes in real-time. A spring-mass mesh, or skeleton, has been created that represents a John Deere 8400 tractor. This skeleton is loaded into the simulator with the visual representational model and interacts with the environment to determine model behavior. We will present our current refinements to the system, its use in subject assessments, and discuss future developments and implementations.

G3.3 Safe Work at Elevation Through Virtual Reality Simulation—Dotson BW, Hsiao, H

Occupational safety research frequently involves measurement of human responses of workers under normal and extreme conditions, in their work environments, in order to provide recommendations to achieve safer work practices. Often, direct measurements of these responses in the field are not practical, due to safety concerns and the complexity and cost of developing nonintrusive evaluation procedures. Virtual reality simulations offer a solution to this problem.

NIOSH researchers are using virtual reality in studies which investigate the physical and mental responses of subjects while working at elevations. These studies will help us to provide recommendations on optimal work settings (e.g., minimum plank width when working on scaffolding at various elevations, visual references for reducing roofers' instability when working on complied or slope surfaces). The virtual reality system that NIOSH developed consists of three main pieces of equipment, an image generator, a surround-screen virtual reality(SSVR) system, and a position tracking system. The image generator produces the graphic images that are viewed on the SSVR. The images projected on the SSVR are stereoscopic, which means the left and right eye images are projected separately. The user wears a pair of LCD shutter glasses, which are synchronized with the projectors so that the user's eyes see the correct image. Viewing the graphical objects in stereo makes the objects appear to be three dimensional.

The VR technology is promising for other applications too. We are assessing the feasibility of 1) establishing a multi-directional treadmill for walk-at-elevation simulations, 2) designing portable motor vehicle simulation platforms for work-zone safety simulations, 3) converting real world images into VR system, 4) developing additional walls for the current VR system to accommodate overhead work simulation (e.g., crane operation), and converting current SGI-driven system to PC-driven to reduce system maintenance cost.

G3.4 Driving Safety and Simulation Technology—Tabacchi JG, Grace R, Guzman AM

Motor vehicle crashes are one of the leading causes of work-related deaths and severe injuries in U.S. workers. The statistics show that many workers are at high risk of injury and death from traffic-related accidents. About three workers die from these crashes each day. It is important to realize that many of these accidents occurred due to human error. The potential of improving driving safety is huge particularly when new technologies such as driving simulators and on-board drivers monitoring systems are used for advanced driver training.

The Transportation Research Center of Carnegie Mellon Research Institute, (CMRI) is involved in research issues related to applications of driving simulators. Together with ISIM, a leader in the field of driving simulators, we have designed and developed an advanced driving research facility. A key component of the Center is its driving simulator named "TruckSim." This simulator allows researchers to safely test drivers under conditions that would be hazardous in the real world. During tests, drivers can be subjected to identical situations while their response and actions are recorded by a multitude of sensors mounted throughout the cab. This system has been used to study drowsiness and fatigue in sleep-deprived drivers and has helped us to develop a drowsy-driver-detection system. TruckSim's modular configuration allows for rapid and cost-effective design of human factors experiments. The system is capable of simulating a variety of road vehicles, using interchangeable cabs mounted on an electromechanical motion platform. TruckSim's driving environments and scenarios can be tailored to study the driver's response to hazardous conditions. Driving errors and crashes can be played back using an aerial view to give the driver another perspective of the road situation. The current and future uses of driving simulators are presented in this paper.

G3.5 Fire Dynamics Simulator—McGrattan K, Forney G, Madrzykowski D

Fire Dynamics Simulator (FDS) is a computational fluid dynamics (CFD) model of fire-driven fluid flow. The model solves numerically the conservation equations of mass, momentum and energy that govern low-speed, thermally-driven flows with an emphasis on smoke and heat transport from fires. A companion software package called Smokeview is an OpenGL graphics program that allows one to visualize the results of the calculations, including animations of smoke particulate, temperature slices within the three-dimensional domain, and heat fluxes to walls. Users of the package can view the enclosure from any angle from inside or outside. Most users prefer to visualize the evolving fire scenario by way of two dimensional animated slices of temperature or gas concentration. Work is underway to introduce these types of quantities by means of three dimensional surfaces, depicting, for example, the layer of smoke near the ceiling of a burning room.

Future developments include the ability to immerse a target, like a fire fighter, within the space so that the temperature and thermal radiation flux to the body can be assessed. Present applications of the model include testing sprinkler performance in storage facilities and warehouse retail stores, reconstructions of fires in residential buildings, and simulations of large outdoor fires. The software is available to the public via the web site fire.nist.gov, and it has been designed to run either on high-end personal computers or engineering workstations.

Session: G4.0
Title: Selected Workplaces
Category: Injury Surveillance and Intervention Evaluation
Moderator(s): Anne-Marie Feyer

G4.1 Fatal Occupational Injuries in the U.S. Rail Transportation Industry—Fosbroke DE, Moore PH

The rail transportation industry is much safer today than in the days of link-and-pin couplers, brakemen jumping from roof to roof to set hand brakes, and train operations regulated by time tables and train orders. Although significantly improved since the 1890s, work-related fatal injury rates in this industry are currently more than twice the national average.

Bureau of Labor Statistics' Census of Fatal Occupational Injuries (CFOI) data were analyzed to assess the magnitude and distribution of fatal injuries in the rail transportation industry. Denominators for calculating fatality rates were estimated using the Current Population Survey. From 1992-1998, 226 rail transportation workers died of work-related fatal injuries in the United States. The fatal occupational injury rate was 11.2 per 100,000 workers per year. These statistics exclude worker fatalities in local and suburban transportation (e.g., commuter and light rail). Fatally injured workers were employed in 36 different occupations, but, 61% of the victims worked in train operation occupations, including railroad conductors and yardmasters (55 deaths), railroad brake, signal, and switch operators (45 deaths); and locomotive operating occupations (37 deaths). Seventy-five percent of cases involved either a railway event (48.2%), or a pedestrian struck by a vehicle or mobile equipment (12.8%). Eighty-one percent of incidents involved a rail vehicle (68.6%), or a motorized highway vehicle (12.8%). Circumstances associated with

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ABSTRACTS

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