EFCOG HPI Task 20-1
Utilizing Technology to Reduce Human Error

Introduction

The ability to preview a task prior to work being performed dramatically improves the success rate of completion. Pre-job briefs, walk-downs, team planning meetings, and the like are all implementation methods that we use for previewing and discussing our work prior to starting the physical activities. Simulators can be created for the purpose of task previews but without the requirement of a field entry. However, creating a simulator for every area and piece of equipment is not feasible regardless of the benefits. As technology advances, it provides us with the ability to create "virtual" environments through visualization that can be leveraged for improving the worker's understanding of the environment and the tasks ahead of them.

"Facility Visualization" utilizing 360° photographs, laser scans, and stereoscopic (3D) imaging, can provide the ability to "walk" through an area or facility without physically entering the space. Through the delivery of the "dollhouse" view (figure 1), these models also provide a method of "perspective" that cannot be gained in the real world easily. This view allows the user to "fly above" the facility and gain perspective on the different areas of the plant. Picture a real estate virtual tour of a house for sale; before you enter the house, you already have a good mental picture of the layout and features of the home. Adapting this same technology, with a few additional useful features, to our hazardous facilities can provide workers with this same level of workspace/area familiarity before they physically have to enter that space.

Introducing such technology can benefit an organization by augmenting current work practices. Current technological opportunities provide methods for visualizing work and work areas prior to entry by providing virtual "hands on" training. Task previews and turnovers can be performed repeatedly for an area or facility using these virtual models. That data can be reviewed and visualized for continuous improvement and updated to reflect configuration changes. As with all changes, this change should be an augmentation of current work practices as new error precursors are introduced and can be identified.

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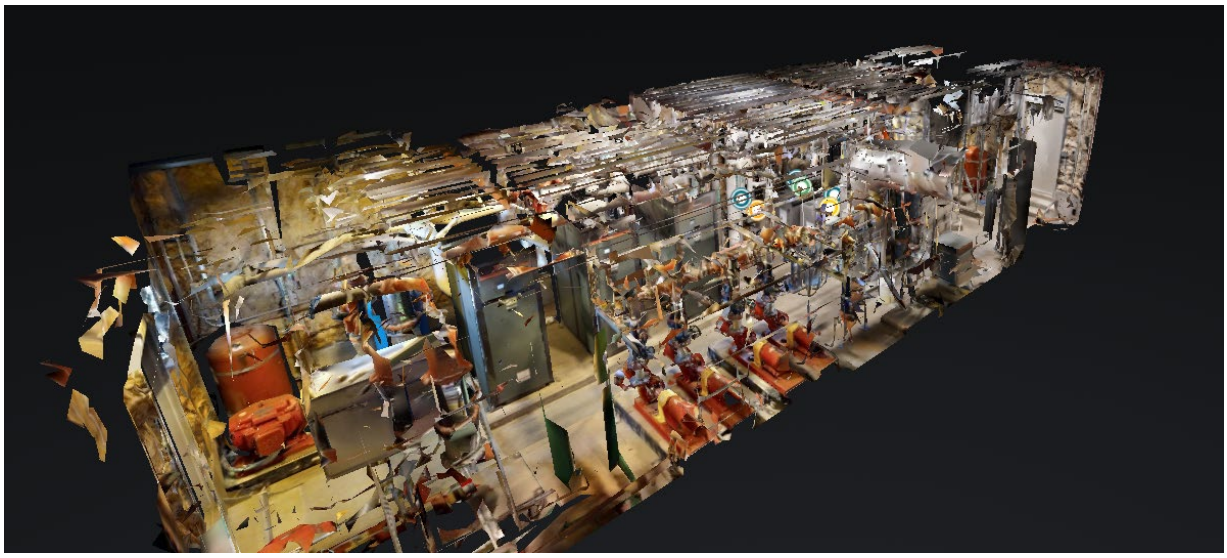

Figure 1

Goal

Computers changed the way business was performed for all of us. With that change, new opportunities for errors were introduced into our daily work lives. As we have adapted to utilizing computers and technology in our daily lives, these error-likely situations have become well known and can be mostly avoided by inserting tools into our work patterns. This paper will explore introducing a new visualization technology into the workplace that provides many benefits to the worker and company, but provides a new method for errors to be introduced.

The goal of this initiative was simple; provide a useful method for workers to perform work planning, review and job-site inspections without the need for physically entering an area. Following As Low As Reasonably Achievable (ALARA) principles, this program would alleviate the need for repetitive entries into potentially hazardous areas for work planning and review purposes. Work planning and work package creation were the first areas that were targeted. Work Planners, the individuals who assemble the work packages, may not have the qualifications to make entries into all areas. Historical photos and engineering drawing were relied upon, as well as field personnel accounts, to create portions of the work packages. Providing the Planners with an up-to-date, high-resolution 360° virtual tour of the area where work would be performed provided valuable information for more accurate work package creation. Adding laser scans of the area to the virtual tours provided Planners with the ability to measure within the virtual models, delivering additional critical information without the need for entering the work area.

As initial roll out began following the strategy, additional areas of implementation were identified by affected personnel. These additional areas and the error precursors that they both mitigate and introduce are discussed in further detail below.

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Training

Using 360° imagery and virtual reality (VR) walkthroughs to augment current training provides personnel with the ability to gain context about a specific training topic by virtually "walking" through the area or facility. Existing facilities can be photographed and converted into training models providing a "real world" scenario that reduces travel time, eases coordination, limits potential exposure and has the ability to identify PPE requirements within facilities or work areas. As the program matures, additional imagery captured during inspection and oversight activities can be utilized to train staff on various facilities and changes without the need of a physical presence in those locations.

Various studies have shown that trainees have a better understanding [(1)] of the content and longer retention [(2)] of the information if VR is utilized during the training process. Students that performed a learning activity using VR scored ~20% higher than students that used traditional training and learning methods. Due to the delivery method of VR content, our brains interpret the information differently than simply viewing it on a slide or information packet. Information retention was also higher, for up to a year, in those students who learned portions of the information through virtual reality.

With this information in mind, Training organizations can leverage VR and virtual tours to provide their staff with immersive learning opportunities. High-risk tasks, potentially dangerous environments, and critical planning activities can utilize these virtual models to provide individuals with the ability to enhance their mental model of the facility or area where work will be performed.

Facilities and areas that require special training or Personal Protective Equipment (PPE) can be imaged by a single qualified individual. These models can then be used by numerous staff for familiarization and training prior to entering the facility. This can eliminate the need for expensive high demand training of an individual that may only need to enter the facility or area once. This not only reduces the potential risk for personnel, but also cuts down on time and cost associated with training personnel for entry into a location once or twice.

Some virtual tour software platforms, InstaVR™ for example, provide "heat map" technology (figure 2) that can be utilized for training staff. As the individuals virtually tour the facility or area, the software tracks where they look/focus and generates a heat map from their time in the area. This heat map can be reviewed to identify areas where staff are looking and where they are not. This information can be used to modify training to highlight missed areas/information as well as support proposed facility modifications to anticipate/match human behavior (sign placement, removal of trip and bump hazards, correct component selection in areas of similar equipment, etc.).

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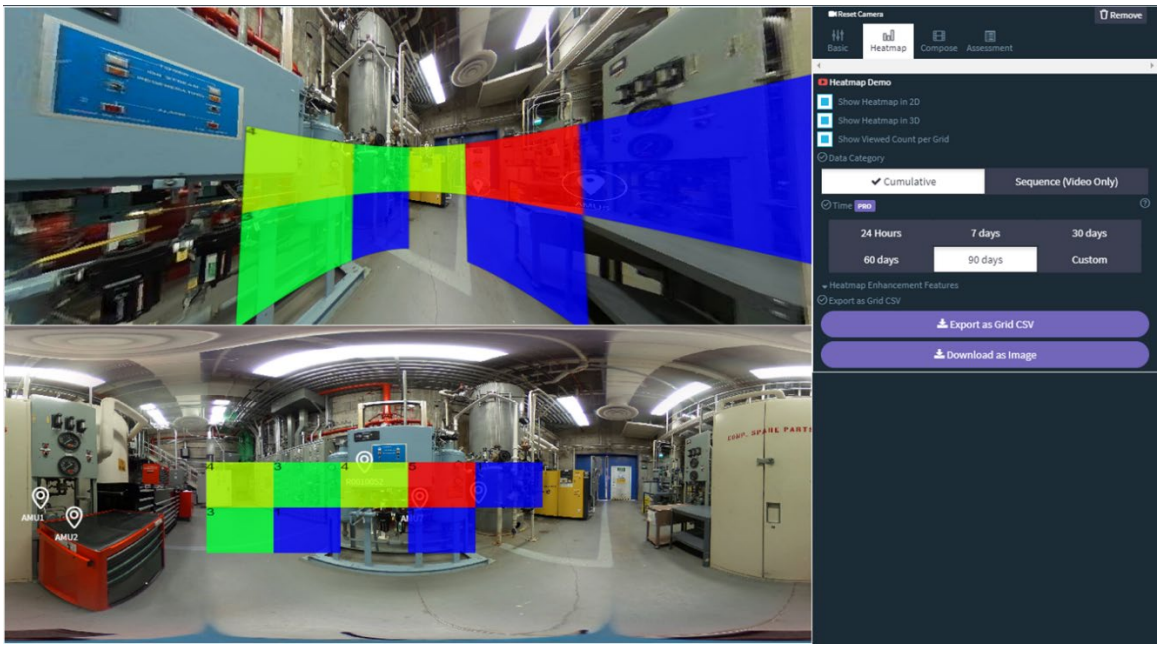

Figure 2

Mitigated Worker Risk (ALARA)

Using 360° imagery, field activities can be captured during various stages of implementation and from various angles and perspectives. Captured 360° images can be "stitched" together to create a virtual tour model using off the shelf software (figure 3). These images and models can be utilized for work planning, pre-job briefs, post-job reviews as well as demonstration of before and after of work completion and modifications. The facility and area models can be viewed through a VR system or through an internet browser. These delivery methods provide the opportunity for both field and office staff to participate in the work activity without the need of entering the field. Images captured during these activities will be retained in a project library that can be used for future training, review and demonstration activities to staff as well as customers.

Benefits of the technology include the following:

- Reduced entries / time in zone and the ability to review/plan numerous times prior to entry into the facility/area
- Improved work planning by utilizing technology for pre-job briefs, planning, and reviews
- Improved oversight / review of environment hazards (unfamiliarity), so non-field staff can review field activities without the need to enter the field

- Ability to add notes / instructions / documents onto each virtual tour model (figure 3). Information can be added to a model to add textual information to an item/area

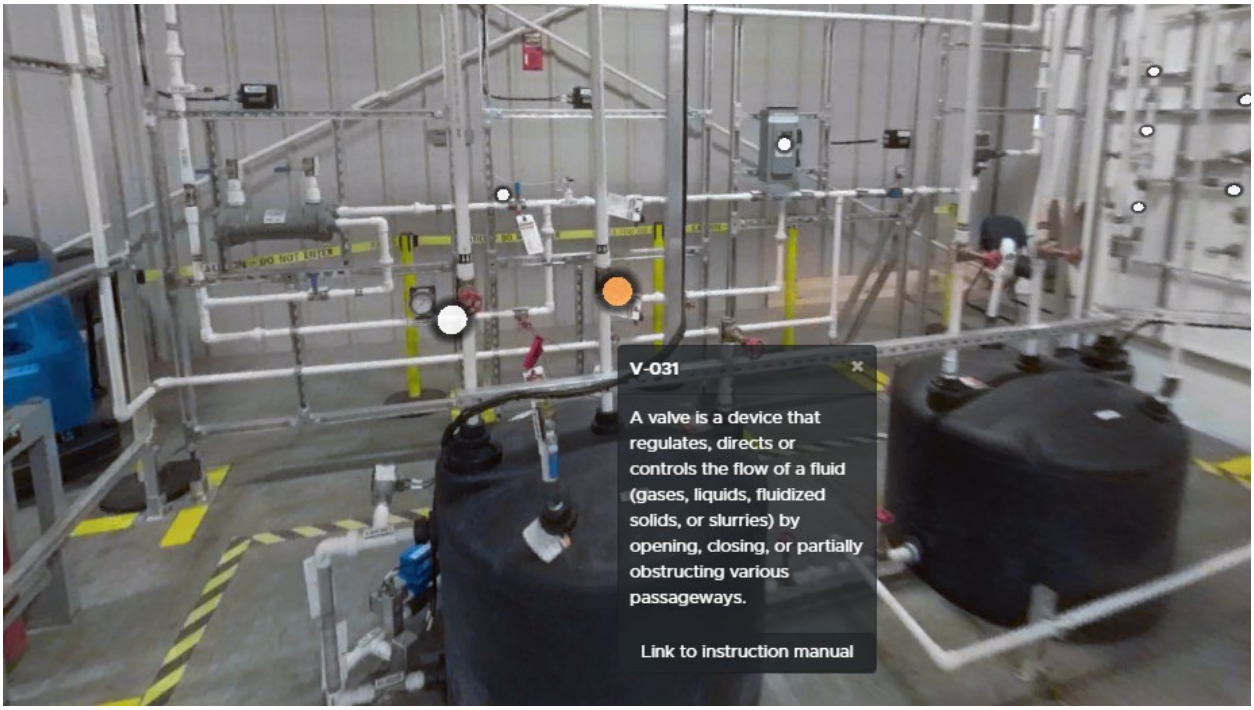

Figure 3

Error Precursor Mitigation

Implementation risk is mitigated by rolling out the technology as a supplement to current activities. Some activities can transition to a fully remote implementation, and others will serve to augment and backup current activities. The introduction of this technology has the ability to mitigate some of the more common error precursors that exist in our daily work lives.

With the ability to view a field facility or area from an individual's workstation, personnel are provided with a less distracting environment than being directly in the field. This can also eliminate time pressures associated with travel times to field locations, in-zone time restrictions, etc… providing staff with "unlimited" time to view and inspect an area where work will be performed. Executing a pre-job brief utilizing these models aid the worker in understanding the environment they will be going into, where the equipment is located, and where other work may be occurring. This the opportunity to free up mental capacity that would otherwise be engage in job site familiarity.

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To ensure individual capability and human nature precursors are addressed during the utilization of these models, staff familiar with the models should be present during the viewing activity while facilities and areas are reviewed. Time can be taken to ask questions, familiarize themselves with the area, as well as address any assumptions with the planned work that personnel may have. Additionally, previous work experiences and lessons learned can be shared during this time. Since individuals essentially have an unlimited amount of time to view and inspect the area through the virtual model, time can be taken too truly review the planned work. Various options and scenarios can also be discussed with individuals that are (and those who are not) familiar with the facility and VR model.

Mitigated error precursors include the following:

- Work Environment
    - Distractions / Interruptions
- Task Demands
    - Time Pressure
    - High Workload
    - Simultaneous / Multiple Tasks
    - Interpretation Requirements
- Individual Capabilities
    - Unfamiliarity w/task, First Time
    - Inaccurate Mental Model
- Human Nature
    - Assumptions

Introduced Error Precursors

As with all process changes, introduction of new error precursors must be evaluated. Many individuals are unfamiliar with how VR technology works and how to apply it beneficially in the workplace. Consequently, individual capabilities may introduce errors into the process from their lack of understanding of the technology. A method to counter this is to augment current processes with the virtual tour technology. As individuals become more "comfortable" with the technology, they can rely on it more heavily than initially.

Additionally, not all personnel enjoy technology or see the benefits of using it in the workplace. Providing individuals with the virtual tour platform as an additional tool they may use could lessen the opportunity for unfamiliarity with the new VR tool to present itself in a negative manner.

As high-tech as these models are, they are still not the real thing. Truly replicating a physical environment is a difficult task and extremely expensive. Due to this, personnel using the models may develop overconfidence or inaccurate risk perception from using the virtual models. As they use the models to plan work, familiarize themselves with the environment,

they build a sense of familiarity of the area. Once in the physical "real world" area, their defenses may be lowered as they feel as if they know the area. This should be addressed in pre-job briefs and discussions about the work prior to entering the facility to ensure that personnel are all aware of the risks associated with the area, particularly noting any unexpected hazards and conditions present that may require additional review.

In addition, technology has a way of easily luring humans into failure. This can be through poor interface design, inadequate user feedback, failing to act on solid feedback, and failing to implement user interface standards to name a few. Recall the 2018 Hawaii false missile alert debacle; this was the result of a poorly designed interface that provided the perfect opportunity for error during a critical task. The system also displayed a pop-up dialog for confirmation of the action. However, this dialog displayed directly under where the user's mouse was and therefore simply required a quick click to acknowledge the action. This "trained" the users into using a "double click" to perform a single action, rather than actually reading and acknowledging the dialog. When implementing a new technology, we must be cognizant of these error traps. Observing users work with the proposed models, as well as soliciting their feedback for improvement, are valuable tools to deploy during the initial implementation phases, leading to improved human factors.

The following is a list of error precursors introduced by the implementation of this technology that needs to be discussed and evaluated to ensure they are minimized as much as possible:

- Task Demands
  - Lack of, or unclear standards
- Individual Capabilities
  - New technique not used before
- Work Environment
  - Changes / Departure from routine
  - Personality conflicts
- Human Nature
  - Complacency / Overconfidence
  - Inaccurate risk perception

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Additional Benefits

Additionally, the facility visualization platform provides the following benefits that can be experienced by multiple disciplines. These benefits can be realized utilizing a browser-based walkthrough or through the use of a virtual reality system.

- Ability to "fail safely"
    - Individuals can be allowed to "fail" in ways not safe in the field, as there is no risk associated with virtually "failing".
    - Training scenarios can be designed for individuals that provide a method to fail, yielding a teaching moment that can be discussed with supervisors, trainers and their peers, supporting a proactive learning environment.
- Repetitive process that can be reviewed real-time.
- Models can be quickly changed to train/test new scenarios.
- Training can be recorded and reviewed by others after completion.
- Peers can watch and "critique" one another in real-time.
- "Gamification" of training within VR can make training "fun" for the workforce.
    - Providing a method of "scoring" during a training scenario promotes a positive competitive environment where personnel *want* to perform the training.

References

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