Virtual Training Studio: Digital Practice Makes Perfect

by Allyn C. Buzzell
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The assembly of explosive devices that actuate air crew escape systems requires highly trained operators and zero tolerance for mistakes. The lives of U.S. warfighters literally depend on the fail-safe functioning of the devices. But how do you ensure such precise manufacturing when there is turnover in the workforce or when experienced operators assemble the devices only periodically as demand requires?

The Virtual Training Studio aims to use digital technology to teach workers to assemble, disassemble, or repair devices and equipment in a virtual environment before they work on the actual items. The joint research program is sponsored by the Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland and the Center for Energetic Concepts Development (CECD) at the University of Maryland (College Park).

Jeb Brough takes a spin in the Virtual Training Studio. Photo courtesy of ONR.

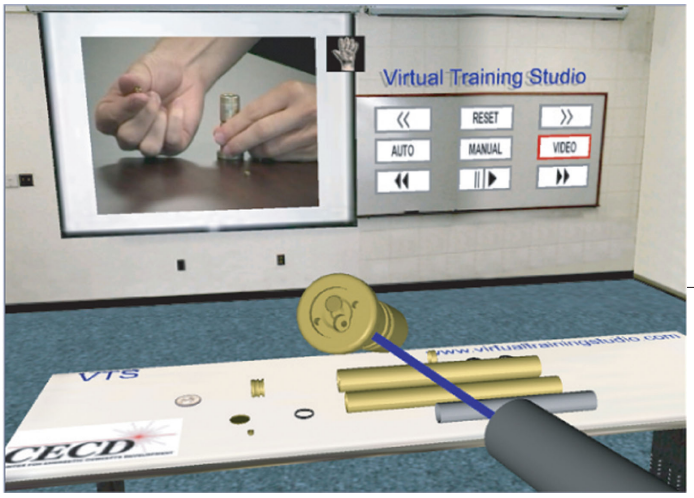
The Virtual Training Studio is the invention of a softwaredesign team led by Dr. Satyandra Gupta, associate professor of mechanical engineering at the University of Maryland. Other primary team members are Dr. Dave Anand, Director of the CECD; Jeb Brough, a former IHDIV employee who is currently a full-time graduate student at the university; and Max Schwartz, a software engineer at the CECD and former student.

The IHDIV team consists of Ralph Pettersen, Director, CAD/PAD Production; Dr. Chester F. Clark, Senior Associate in the Joint Program Office for CAD/PAD; and Cindy M. Yeager, Senior Staff Engineer, CAD/PAD Production.

According to Dr. Clark, "The Virtual Training Studio gives us the opportunity to train our employees on manufacturing processes that are done only intermittently and also to archive the processes for future training as our production workforce and engineering staff change over time."

In the Studio

Trainees interact with a tutorial using a head-mounted display and hand-held wand. Four optical trackers and two gyroscopes track the position and orientation of the trainee and the wand. The



Tutorial shows trainee a video of assembly process.

trainee manipulates the assembly parts and clicks on various response buttons using a virtual laser pointer.

Several modes of interaction are possible. In the interactive simulation mode, users can position and orient the parts of the assembly. Once the configuration is properly aligned, the user clicks on the "complete" button and watches the animated completion of the assembly.

Trainees can also visualize how the task is done by choosing the animation mode, which shows the components being assembled. Another option, the video mode, plays a video clip of an actual part being attached to the assembly. The user can watch the video and repeat, pause, rewind, and fast forward to study the various assembly tasks.

According to Dr. Gupta, such training maintains the user's proficiency and reverses memory attrition that may occur when performance of a task is sporadic. The researchers are currently enhancing the training module by adding virtual tool usage capability.

Better All the Time

Employing artificial intelligence features, the Virtual Training Studio tracks errors by individual users and responds by making adjustments or clarifications in the tutorial or by presenting a different scale or perspective on the assembly process. For example, if a user did not remember what part to assemble next (a process retention error), the assessment component instructs the tutorial to replay a short sequence of steps.

The assessment component also analyzes multiple user logs and answers to the mandatory exam to detect points in the assembly process where many users make errors, uncovering possible weaknesses in the tutorial itself. The assessment component then attempts to clarify the tutorial by adding visual aids (such as arrows) or additional text or audio instructions.

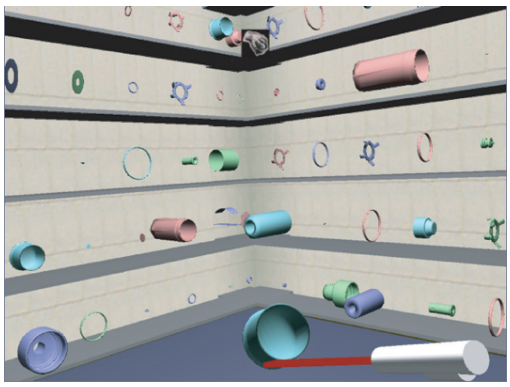
Engineers also have the ability to build new assembly protocols. Using the authoring module, the engineer loads a set of files that describe an assembly. The module then creates an animation sequence for the assembly and generates a text outline of the process, using object motion and collision detection. The engineer can edit the instructions and then incorporate them as a new tutorial in the training module. The engineer can also print them to create a paper-based manual.

Payoffs Now and Later

The Virtual Training Studio yields important benefits in the areas of manufacturing efficiency and safety, product quality, worker proficiency, training effectiveness, and instructor productivity. Besides its near-term application at IHDIV's manufacturing facilities, other uses will evolve.

"Our immediate interest is to improve the visualization capability and memory retention of workers in a manufacturing setting," says Dr. Gupta. "However, one could imagine many natural extensions for our research."

One such potential military use might be to develop virtual training software to support equipment maintenance proficiency right on the battlefield.



Assembly components in the Virtual Training Studio. Photos courtesy of ONR.