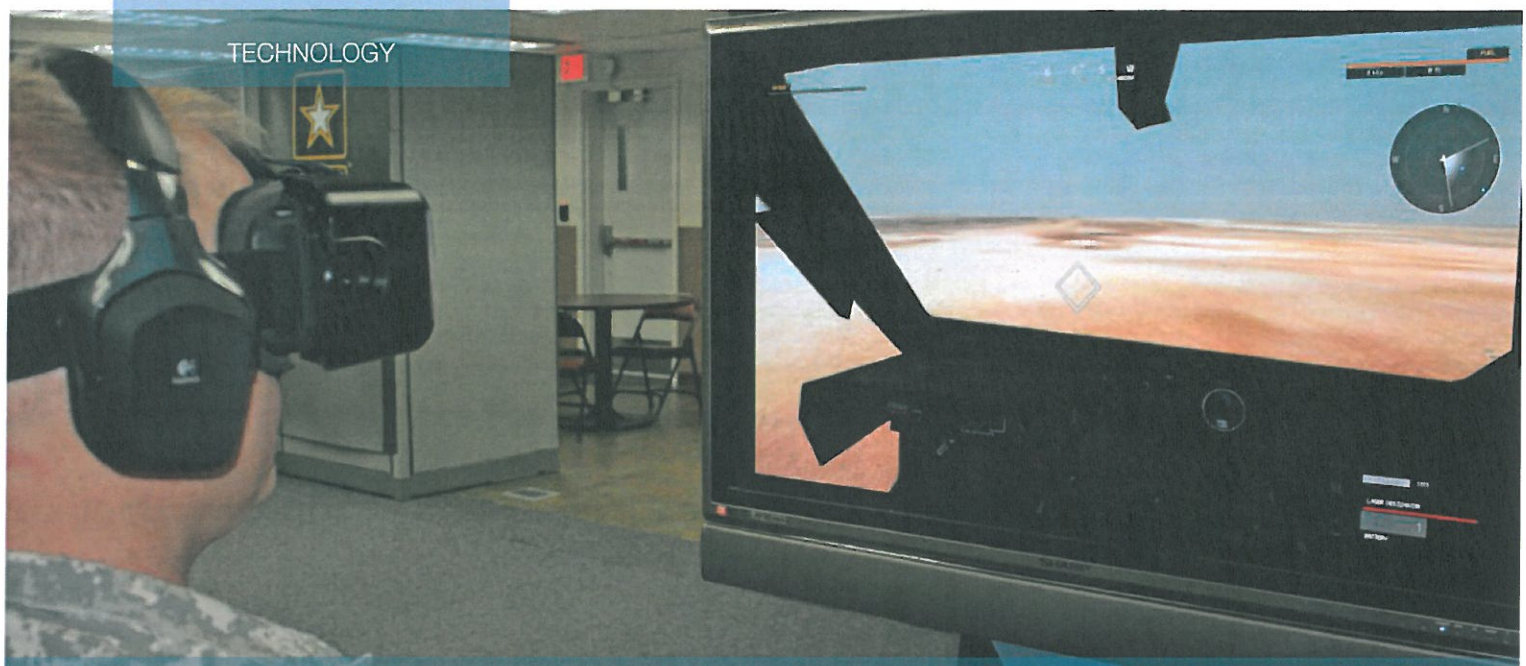

Holograms - a Work in Progress

Group Editor Marty Kauchak examines one recent effort to advance the technology baseline for holograms and its implication for military simulation and training.

This July 16 the US Patent & Trademark Office published a patent application on digital infrared holograms originally filed on January 13, 2014 by Rigel Q. Woida-O'Brien of Raytheon. While the patent document lists the applicant's address as Raytheon Company of Waltham, Massachusetts, Woida-O'Brien is in fact assigned to the company's Raytheon Missile Systems office in Tucson, Arizona, a company spokesperson said.

According to the application, Raytheon's hologram technology involves projecting infrared scenes using a series of "micro-mirrors."

The potential technology advancement should resonate well with the military-industry simulation and training community. In one instance the technology application "may be used to generate dynamic scenes for purposes of simulations or tutorials, such as training exercises for military personnel," read the government form.

The spokesperson for Raytheon's Tucson office declined to respond to this author's email submission of additional queries on the topic.

Service Insights

Any use of holograms in mainstream US military training appears most feasible well beyond the services' five-year program and budget horizons – indeed, well into the next decade – and will be driven by what is expected to be gradual advances, rather than revolutionary breakthroughs, in the underpinning technology.

LTC Jason Caldwell, the chief of the Futures Division at the National Simulation Center, provided one service insight on the topic. Caldwell spoke with *MS&T* this July 30 in his capacity of defining the technology requirements that will deliver future training capability for the US Army.

The former infantry officer and current Simulation Operations (FA57) officer pointed out the Army's interest in holograms is part of a broader, three-part, incremental approach to move the service beyond the live-virtual-constructive-gaming environment.

On his service's close-in, training horizon is refining virtual reality, which is typically enabled by fully-immersive goggles worn by the training audience to display a virtual environment. "This permits you to interact with the environment, move around and view it from different angles," Caldwell explained, but added the trainee is not able to see any of the "real world". Rather, he noted, "you remain in the virtual environment."

The Army is also advancing the state-of-the-art in augmented reality (AR). "This shows a lot of promise and adds a lot of the 'richness' of the virtual environment." Caldwell remarked. Trainees in an AR scenario see people, buildings and other virtual entities in a live environment. The Army M&S authority noted one application for AR could permit a unit training at home station to use a mockup of a village at a near-by training area. "Using a set of AR goggles allows you to transform that training area into something that looks much more com-

Above
On the US Army's close-in training horizon is refining virtual reality, which is typically enabled by fully-immersive goggles worn by the training audience to display a virtual environment.
Image credit: US Army.

plex like the current operational environment. You could see thousands of people, buildings, or both friendly and enemy vehicles, that aren't actually there," he pointed out. With AR, the training audience is also able to complete missions that otherwise could not be completed in live or virtual environments. "The benefit of augmented reality is doing things you otherwise could not, because of cost or safety constraints – the safety zones used to train artillery or mortar crews for instance. Other training is a bit artificial because of the safety zones that prohibit soldiers from being injured in training," Caldwell emphasized.

The service also has its research and development focus on holograms – viewed as a technology maturing for training purposes "in the mid-2020s, around 2030", Caldwell estimated.

Holograms in their pure form allow the user to manipulate light and present a 3-D photographic recording of a light field – rather than of an image formed by a lens – when it really is not. The Fort Leavenworth-based officer said a current impediment for using hologram-based technology in military training applications is the need for a medium (smoke, fog, water vapor or another) to help alter the system's light. "You need something to manipulate the light and give that illusion to the training audience. That may be difficult to do in a live training area. But as we look to the future we have a lot of buildings on Army posts. Perhaps we could repurpose and provide those types of environments by creating climate-controlled rooms or other enclosed areas. They could allow you to use and manipulate lasers to bend and project light in such a way that, for example, you could use a hologram to make you believe that was a villager you were going to engage, or perhaps an enemy soldier in a room."

Similarly, Darrel Hopper, PhD, the principal electronics engineer, at the 711 Human Performance Wing, Air Force Research Laboratory, said fixed holograms are a relatively mature technology and have been used for many years in operational planning settings. Yet, he added, "Electronic visual holographic motion displays are very immature (TRL [technology readiness level] 3-to-4), and are not used in current simulation or operational applications."

The Air Force expert also emphasized the early, recognized potential of hologram-enabled learning, pointing out fixed holograms have been demonstrated to increase training effectiveness and information retention in a variety of studies. "However, the use of '2.5D' systems (2-D displays driven by workstations running 3-D data sets) is now more effective in terms of warfighter performance and is more affordable."

While the hologram technology base matures in graduated steps, there does not yet appear to be any urgency within the E-ring of the Pentagon to establish requirements and accompanying funding for related projects. Indeed, the Air Force's Hopper noted there is no longer any significant investment by any program of record in fixed holograms; this work has moved to the Department of Homeland Security. "Regarding motion holographic displays – there will be no program of record investment until the TRL and MRL [manufacturing readiness level] reach level 6 (which will be many, many years)."

Hopper also emphasized that current US Air Force investments are in technology efforts (SBIR (Small Business Innovation Research)) to mature the various electro-optical components, optics, algorithms, software, processors, and standards that will guide the building of future holographic Field of Light Display (FoLD) prototypes.

Similarly the Army does not have a formal requirement or program of record to use holograms in training applications. mst