Army Draws 'Map' for the Multidomain Megacity

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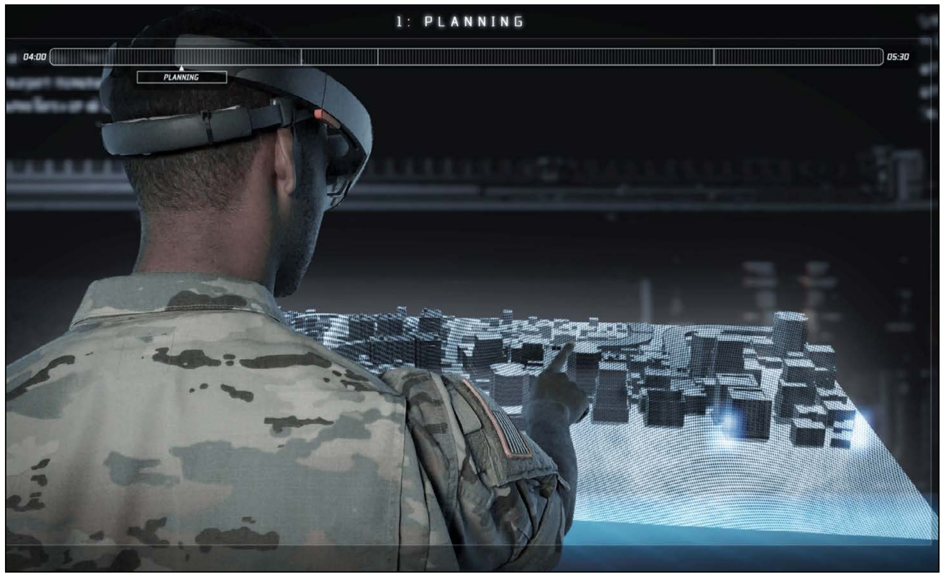


Data-rich 3-D maps would let Soldiers spend time viewing terrain from a variety of perspectives to gain an intuitive sense of the battlespace before operations begin. That basic understanding of the physical environment and how to navigate it improves spatial memory.

Today's Army leaders consider it inevitable that U.S. ground forces will engage in combat in dense urban environments, including building interiors and subterranean spaces. These settings eliminate or severely degrade many of the technological advantages that U.S. forces and their global (near-) peers have developed over several decades, and they also may provide sanctuary to friend or foe. Dense urban environments also heighten broader risks of unintended consequences in combat.

A broad spectrum of existing and emerging research topic areas has shown the potential to develop significant capability for providing small disaggregated mounted and dismounted teams the ability to act independently, to out-think and to outmaneuver the enemy in close combat despite limited and intermittent access to higher-echelon command and control. Most of the promising science and technology (S&T) development focuses on major advances in situational awareness in urban settings and how they can lead to better decisions faster, presenting dilemmas to an adversary.

The Army S&T community has adopted the premise that urban combat, considered as a flowing series of tactical unit decisions and actions, will greatly benefit from rich and intuitive space and event and trend context. Accordingly, near-term and emerging research areas at the U.S. Army Engineer Research and Development Center (ERDC), the U.S. Army Research Laboratory (ARL), and the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) include investigations into the design and formulation of new urban terrain data models, frameworks, and cognitive display approaches. The goal is to identify solutions compact enough that many Soldiers and every vehicle can carry them along for sharing and analysis, while meeting a variety of needs for display on different equipment. Research interest across the ERDC and the U.S. Army Research, Development and Engineering Command also has focused on characterizing, moving, and communicating within the confined space of building interiors and subterranean infrastructure.

Results of this research will shape design and development of techniques for much more rapid data generation, tailored dissemination, change analyses, and visualization. In other words, Soldiers will learn as they go and retain this spatial knowledge. This new direction, in most cases, markedly departs from the commonplace use of flat maps.

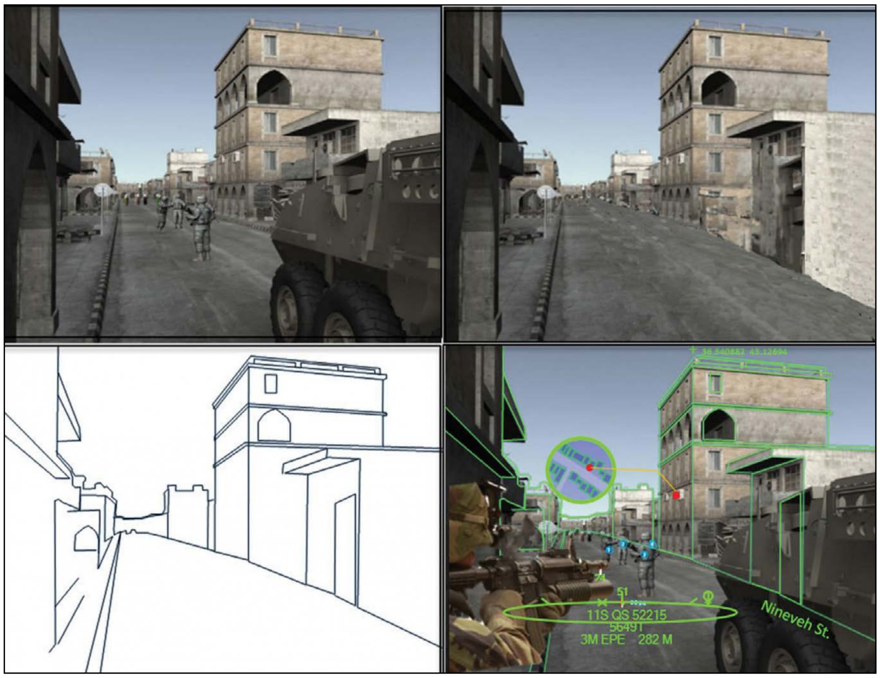
The 3-D Urban "Map"

The goal of Army geospatial research is to design, develop, and test a new, multidimensional 3-D "map" of urban infrastructure geometries, materials, and functions. This capability would provide the context and baseline for a variety of Army operations. Current research efforts focus on some key attributes that such a map — really an information architecture — would include:

- Available on demand to Soldiers and their applications, particularly in its small units;
- Measurable and supporting a variety of automated analyses;
- Updatable as conditions change; and
- Intuitive displays for more rapid decision making.

Let's consider a requirement for 3-D urban terrain data available to the Soldier before deployment. First, by the time Soldiers deploy, the standard urban geospatial load may not have the most up-to-date geometries and other relatively static conditions in the area of operations. Second, units may need to know what has changed during the course of combat operations. Accordingly, we must consider the need for an organic capability to rapidly generate new 3-D data to upgrade gaps or other uncertainties in the standard geospatial load. This same function also becomes a change detection capability when comparing new data with existing information.

These two key considerations support sequential, in-stride rehearsal, movement and maneuver, targeting and battle damage assessment; navigation, targeting, and other sensing systems can "see" the real urban environment and compare



These are some of the views possible with an enriched, 3-D visualization of a given area. Clockwise from upper left, a high-resolution representation; a version that filters out ephemeral objects such as passing cars; augmented reality view with edges and corners georegistered and attributed; and extracted edges and corners.

that, in real time, with urban information on board to move, learn, and assess. Think of three tiers in an open modular architecture for 3-D enriched urban terrain information, two of which involve inspecting the operational environment while the third deals with improving support for decision making and execution by analyzing data in hand.

Form, Fit, and Function

The prospect of 3-D enriched, high-resolution urban terrain with near real-time updated tactical overlays does not necessarily constitute operational improvement and leap-ahead advantage. We can observe in the world every day the distraction and operational slowing caused by visual displays, personal and otherwise, as well as our dependence on them. To integrate and distill sufficient situational context — mission, enemy, terrain and weather, troops and support available, time available, and civil considerations (METT-TC) — so that leaders of small units can make better decisions faster, a relatively new body of research is looking into the form, fit, and function of visualization to catalyze a strengthening of intuitive understanding. From training to rehearsal to operational use, visualization requirements differ. With immersive training and research toward a fully synthetic training environment, and with mission planning at brigade and above, research challenges — near-term and enduring — appear well defined.

For close-quarter combat in complex and especially dense urban environments, questions about what, when, and how to visualize the data products described above become paramount. For example, the ability to move at will in dense urban environments and simultaneously force dilemmas on an adversary, as well as to manage risk, may depend on very short-lived multisensory (i.e., audio, visual, tactile) cues that bolster the retrieval and application of spatial memory. Can we train, rehearse, and cue a Soldier to navigate in the city as effectively as the native city dweller?

Recent Army research at NSRDEC has demonstrated important trade-offs among the timing and type of information conveyed to a user, the attentional demands of the information, and outcomes for individual and small unit performance. If, during mission planning and preparation, Soldiers visualize the intended operating area in 3-D from multiple perspectives and orientations, their spatial memory can improve; this increases their ability to move effectively through complex environments with constantly changing situations and demands on their attention.

Not a Silver Bullet

Army research has demonstrated that during combat operations, standard navigational displays can induce complacency, divide attention, and disengage navigators from their environment. This can impair the development of flexible spatial memories Soldiers must rely on during times of heightened stress. These and other research outcomes present a challenging focal point for developing next-generation visualization technologies, such as chest-, helmet-, eyewear- and torso-mounted information systems that provide timely and relevant information without compromising the ability to think and act quickly and effectively. The Army's geospatial, training, and Soldier S&T communities are working collaboratively on this challenge, including developing scenario-based virtual test beds to predict and quantify performance outcomes of future systems, the development and application of which span from the near to the far term.

Conclusion

With our current technology and doctrine, we can level the playing field in complex and congested environments — including dense urban and megacity domains — by degrading standoff and other advantages. Integrating capabilities like next-generation autonomous networked sensor platforms, heads-up situational awareness for small units and enhanced fusion and targeting has the potential to restore U.S. tactical advantage. Providing rich, detailed, and actionable place and event context through analysis and visualization has great promise to give options to tactical commanders among integrated and available capabilities to make our adversaries' intentions unattainable.

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