

## Developing a Tactical Geospatial Course for Army Engineers

*By Jared L. Ware*

*“ESRI technology, such as the templates, gives the Army an easy-to-use, technical advantage that helps Soldiers optimize GEOINT capability resident in DCGS-A”*

Colonel Ed Riele, TRADOC Capabilities Manager for Sensor Processing

The United States Army has been engaged in persistent operations for the past 15 years, with missions ranging from combat operations in Iraq and Afghanistan to providing humanitarian support for the Ebola outbreak in West Africa. Every operation has involved Army engineers and every operation has required the most up-to-date geospatial products. During the past 15 years, geospatial systems, data, and applications have changed significantly, mainly transitioning from stand-alone, single-source systems to web-based applications where updates can be made instantaneously and shared with multiple users from an enterprise database. During this time frame, the Army’s geospatial force structure has changed to where geospatial engineers are now integrated into tactical staffs from the battalion to Corps level, and recent doctrinal updates assign Engineer Brigades the responsibility of maintaining geospatial enterprises. However, the one thing that has not changed in the last 15 years is that no course exists to train Army engineer officers on the application of geospatial engineering for tactical operations. Although Army engineer officers are expected to be terrain experts in addition to providing engineering expertise during operations, there has never been a training curriculum for engineer officers dedicated to the application of geospatial engineering for tactical operations. The purpose of this paper is to explain development and implementation of the Geospatial Engineer Tactical Operations Course (GETOC) for Army engineer officers as well as how ESRI software is being used in the process.

There have been courses ranging from a 10-week mapping, charting, and geodesy course to a 2-week tactical operational management course, but nothing specifically dedicated to instructing engineer officers on becoming terrain experts at the tactical level. Captain Nicolas Cosmas, upon completing an engineer company command, wrote in the *Engineer Professional Bulletin* in 2013 that “we must restore the premium once placed on geographical competence, and engineer doctrine and programs of instruction should reflect this.”<sup>1</sup> Although several ideas for new and updated terrain analysis, topographic engineering, and geospatial engineering curriculum have been developed, no single course has fully linked the doctrine, program of instruction, and knowledge expected of company-grade engineer officers with respect to understanding geospatial engineering for tactical operations. Legacy courses and curriculum focused on one of two areas: teaching engineer officers to become technical experts in some facet of what is now called geospatial engineering, or how to better understand a landscape and its features as it related to the employment of engineering equipment and weapons systems for combat operations. Every year a select few engineer officers are selected to attend graduate school in a geospatial engineering-related discipline, particularly those who have demonstrated an interest and aptitude in the academic discipline. However, by this point most have completed their primary company-grade Army requirements, and will not use what they learn in graduate school in a tactical operations context until they return to an engineer battalion.

## Course Development

With geospatial engineering being one of the three engineering functions (along with combat engineering and general engineering) it is imperative to train officers in geospatial engineering early in the development cycle so they can best apply the knowledge to the tactical situations that they will face as platoon leaders, staff officers, and company commanders. Figure 1 below shows that Operating-force engineers in the Engineer Regiment deal with every engineering function, with geospatial engineering being a main function for both planning and operations.<sup>2</sup> A recent update in geospatial engineering force structure, doctrine and review of existing curriculum at the U.S Army Engineer School outlined a need for additional geospatial engineering training, with a focus on what engineer officers require in terms of geospatial knowledge for planning and executing tactical operations.

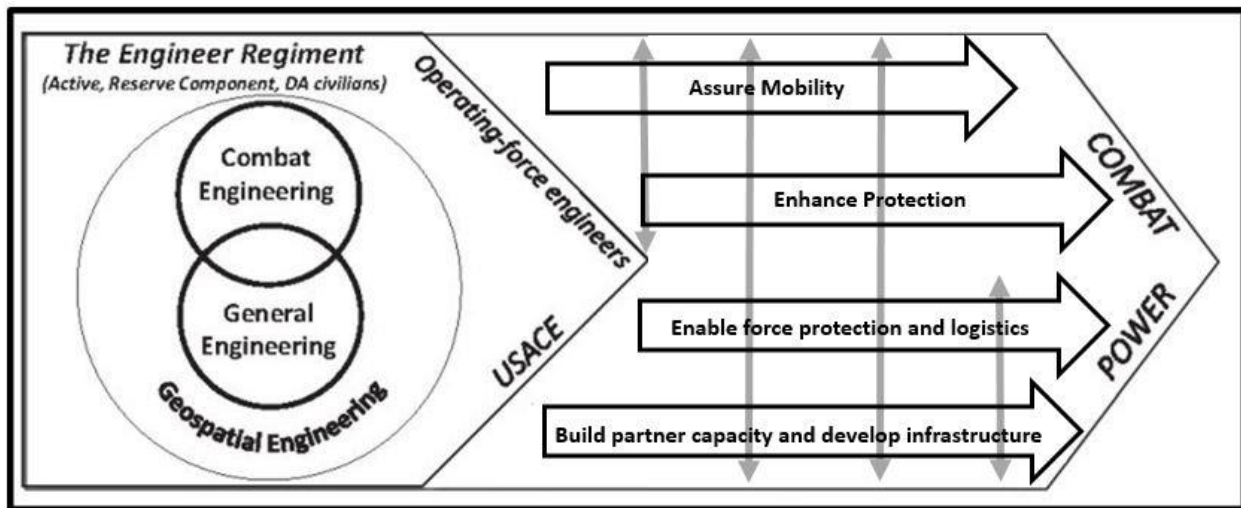


Figure 1: Engineer Functions, Engineer Formations and Lines of Effort

To address the need for additional geospatial engineer knowledge for company-grade Army engineer officers, a pilot course was developed by the 20<sup>th</sup> Engineer Brigade in 2013. The pilot course focused on training geospatial engineer platoon leaders in the 100<sup>th</sup> Engineer Company at Fort Bragg, North Carolina on how to understand and manage geospatial requirements in support of combat, contingency, and humanitarian operations. This instructor-led course integrated the academics of geospatial engineering with a “hand’s on” approach to using the Army’s geospatial engineering systems and software. Students were introduced to ArcGIS 9.3 and 10.1 because both software versions were present in the Army’s Digital Topographic Support Systems. Students also used ArcReader during a practical exercise gain an appreciation for how data could be shared to customers who did not have ArcGIS software on their systems. Feedback from the pilot course included keeping the course at 24 hours of instruction, which allows students to spend more time during the capstone exercise exploring the capabilities of ArcGIS software. Feedback also included making the course portable to train potential operational partners (National Guard units, interagency personnel, and coalition units) who may require geospatial engineering knowledge. The course, named the Geospatial Engineer Tactical Operations Course (GETOC), completed an additional iteration in 2014 for members of the 100<sup>th</sup> Engineer Company and the 30<sup>th</sup> Engineer Battalion at Fort Bragg, with minor updates made in the syllabus and course content based on course feedback.<sup>3</sup>

## Course Design

The Geospatial Engineer Tactical Operations Course is now being designed to address the need for geospatial engineering across a broader spectrum of tactical operations that engineer officers may encounter. The GETOC will use ArcGIS 10.4 and ArcReader 10.1 or 10.4, given that some users have not upgraded to the Windows 10 operating system. This software enables Army engineers to learn the basics of geospatial analysis as it applies to tactical military operations. In the future, ArcGIS Earth will be implemented as more users become accustomed to web-based services and applications.\* Overall, GETOC development and design uses ESRI's ArcGIS as the primary software based in the software's ease-of-use, flexibility, and commonality across the defense community. The major benefit from the course is receiving a quality "hand's on" educational experience using realistic data and ESRI software.

The idea behind GETOC's current development and implementation is that United States Army has no single course to train engineer officers to understand the tenets of geospatial analysis. The most recent engineer training strategy expects to develop newly commissioned officers into leaders capable of supporting the primary function of terrain visualization, combat engineering, force-support engineering, and battle command.<sup>4</sup> Currently, no curriculum exists with up-to-date geospatial information for addressing the various tactical scenarios officers could face as leaders of small units. A major requirement exists to provide company-grade engineer officers with a baseline knowledge of the application of geospatial engineering at the tactical level in support of full spectrum operations. A major goal is to develop a course that can be completed in less than 40 contact hours and still meet the training requirements. Although not specifically outlined but implied was that the course would not require an increase in instructors, computer labs, or any other resources. From that pilot course it was found that a 24-hour course can provide students with a basic understanding of geospatial principles, as well as what is required to create geospatial products that best support tactical military operations. The GETOC will provide students the ability to use ESRI software to explore nine fundamental concepts, to conduct geospatial analysis during a capstone exercise, and to complete a final course exam.

The concepts cover a range of geospatial engineering topics to range from understanding the availability of geospatial information and services to conducting geospatial analysis using digital products. The final capstone exercise can be conducted with either ArcGIS or ArcReader (or both), as students will be provided a pre-existing data set created with ArcGIS that is also viewable with ArcReader. The final exercise will integrate all curriculum covered throughout the course and allows students to work in teams to conduct geospatial analysis for the development of a realistic tactical operations briefing. Based on student feedback from the pilot GETOC, the course provided the proper amount of time and information to meet baseline requirements for an introductory geospatial engineering course. It also allowed flexibility in completing the course for National Guard and Reserve Component personnel who have limited training time and resources but want to increase geospatial engineering knowledge within their respective units. A major benefit from the course is receiving a quality educational experience using realistic geospatial data within ESRI software, as the GETOC adds some context to the use of geospatial software and students take a "hand's on" approach to completing the capstone exercise.

## Grounded In Doctrine

Army engineer officers are expected to understand how to integrate geospatial engineering into the Army's warfighting functions, specifically being able to describe the effects of terrain in tactical operations. Doctrinally and organizationally, engineers are members of the Army Maneuver Support Center which focuses on the *Protection* warfighting function. Engineers are also responsible for the integration of geospatial engineering throughout the operations process, which includes the understanding of terrain for friendly forces under the *Movement and Maneuver* warfighting function to the understanding of an enemy's order of battle for the *Intelligence* warfighting function.<sup>5</sup>

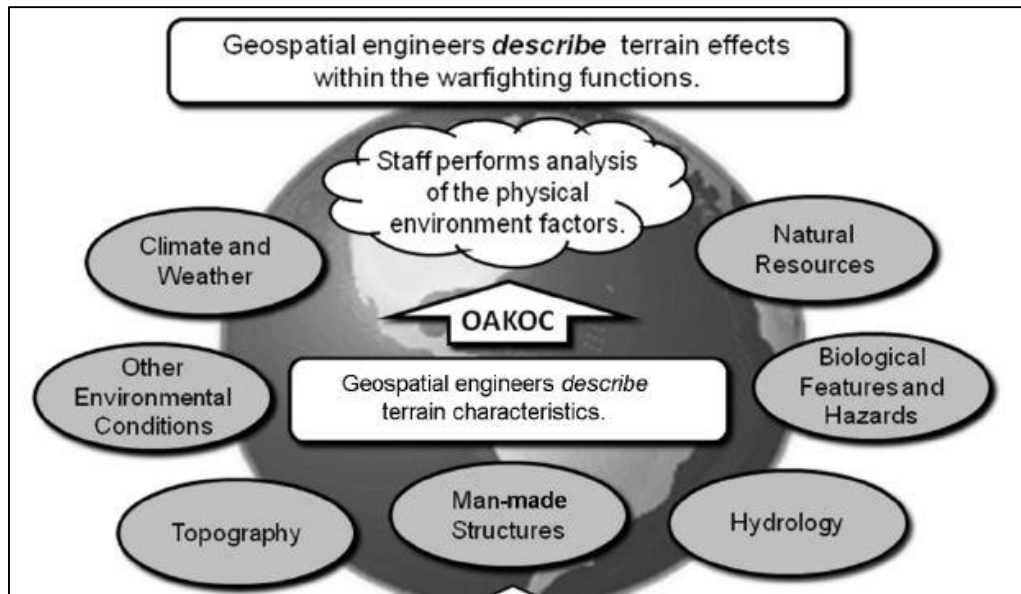


Figure 2: Geospatial Engineers Describe Terrain Characteristics

To accomplish the requirements and tasks, engineer officers need a solid understanding of geospatial engineering and a working knowledge of how the products are created, produced and shared using ArcGIS, which is the GIS software-of-record in the Distributed Common Ground System – Army (DCGS-A). The Distributed Common Ground System – Army provides a workstation specifically designed for the processing, exploitation and dissemination of geospatial data. As the core system to manage Army tactical geospatial data and enable Army warfighting functions, it provides tactical units the ability to view, process, and share geospatial information.<sup>6</sup> The workstation has ArcGIS software that allows analysts to process geospatial data, analyze products, create maps and develop decision aids in support of terrain analysis and visualization. To keep the "look and feel" consistent with the GIS software resident in DCGS-A, the GETOC was designed to use ArcReader as a viewer for any user that does not have access to DCGS-A or ArcGIS through another venue. It also enhances a user's understanding of the data formats, software functionality, and GIS workflow.

One example developed in the GETOC capstone exercise using ArcReader is gaining an understanding of the tactical environment and the data available to address the requirements and tasks for the tactical scenario. In Figure 3 below, the student is introduced to the software and data for the area of operations. The data set includes a mix of vector and raster data that will be used by the students to answer a series of questions for the tactical scenario. All of the data provided will assist the students in describing the terrain, landscape, and physical environment using ArcReader or ArcGIS 10.X.



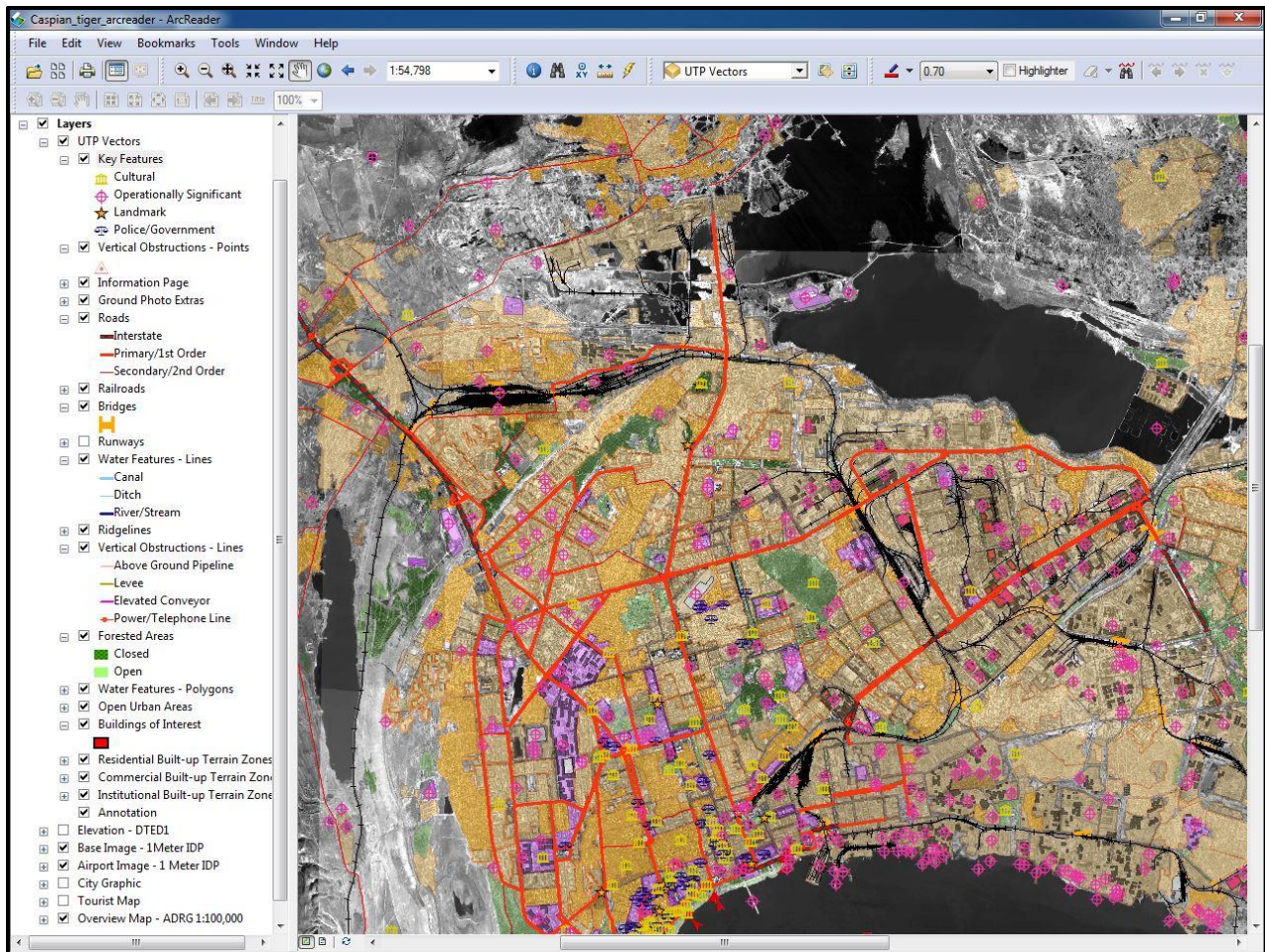


Figure 3: Area of Operations (Tactical Scenario in ArcReader)

Geospatial products at the tactical level include the creation and dissemination of helicopter landing zones for air assault operations. This type of product is associated with the *Movement and Maneuver* warfighting function. The example in Figure 4 includes finding a suitable helicopter landing zone within the urban area of operations.

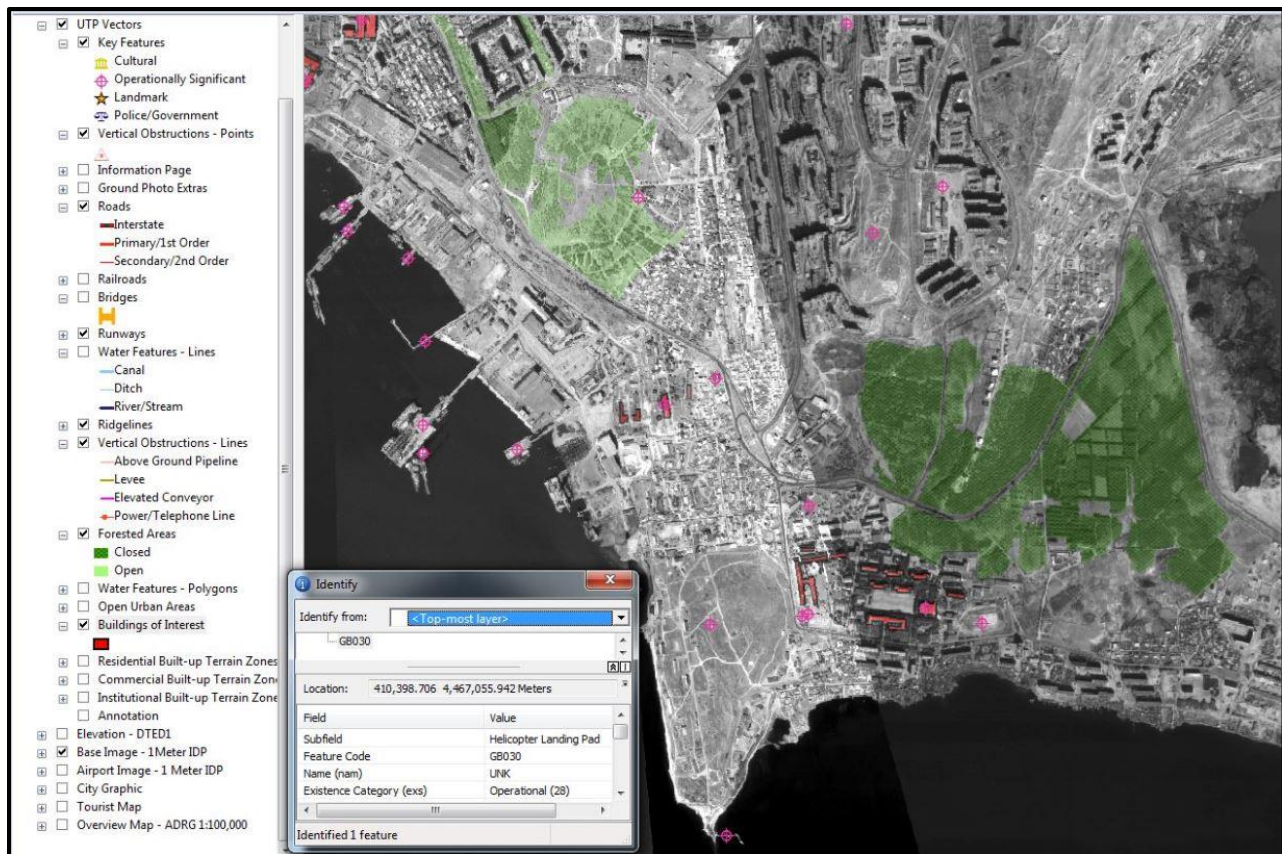


Figure 4: Identifying a Suitable Helicopter Landing Zone (Tactical Scenario in ArcReader)

The recent release of ArcGIS Earth 1.1 and its functionality will be a way to address geospatial engineer training for those that may not have full access to more robust ESRI software. Since the GETOC capstone scenario is developed with data that can be uploaded into ArcGIS Earth, this is a possibility that in the future the course will migrate to ArcGIS Earth<sup>7</sup>. At a minimum, the current program is to use ArcReader, but early testing has shown promise for being able to use ArcGIS Earth. The example in Figure 5 below shows the data set in ArcGIS Earth (and originally developed for ArcReader). It outlines vertical obstructions that are present in the tactical area of operations. Additionally, the curriculum will introduce video clips created to show how to use the software in a step-by-step process. The video clips will have data associated with the area of operation, and will cover how to create geospatial products that can be used for the final capstone exercise. The video clips can be used within a classroom environment to augment an instructor leading the course, or it allows for the course to be completed online and without an instructor being present. This adds to the flexibility of the course in terms of the overall delivery methods. It allows a student not taking the course in a classroom to gain the software knowledge online prior to using it for the final capstone exercise.



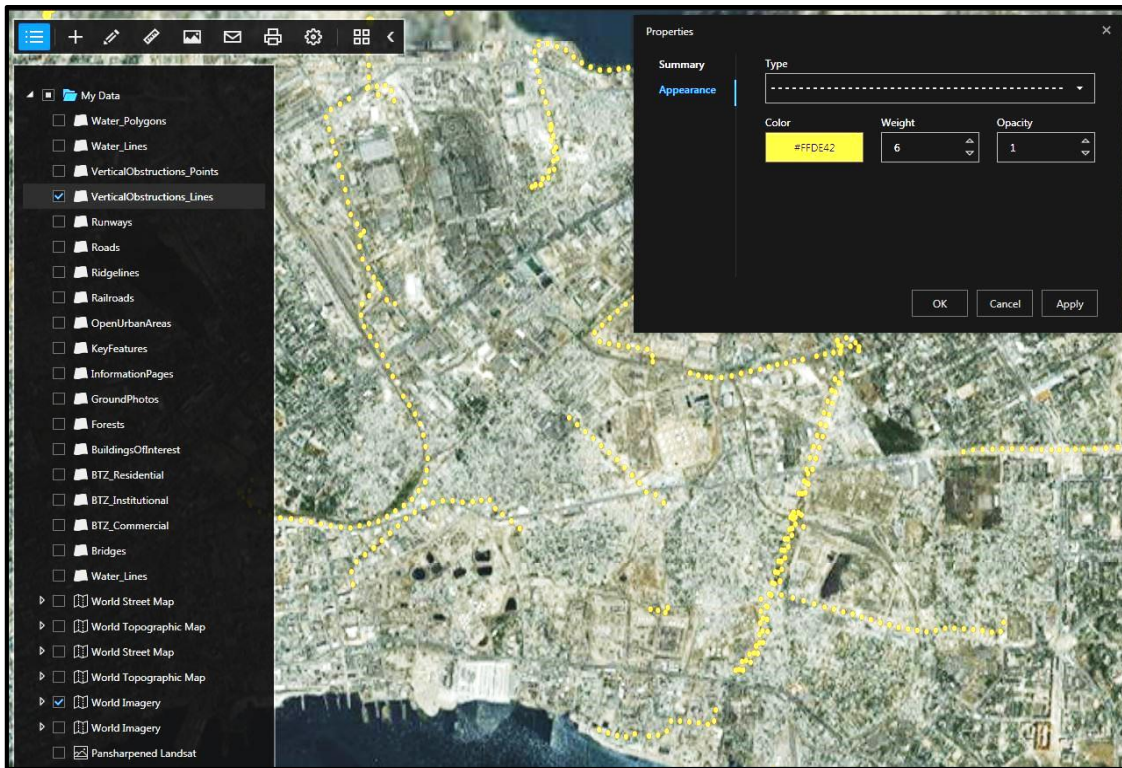


Figure 5: Displaying Vertical Obstructions (Yellow Dots) for a Tactical Scenario in ArcGIS Earth

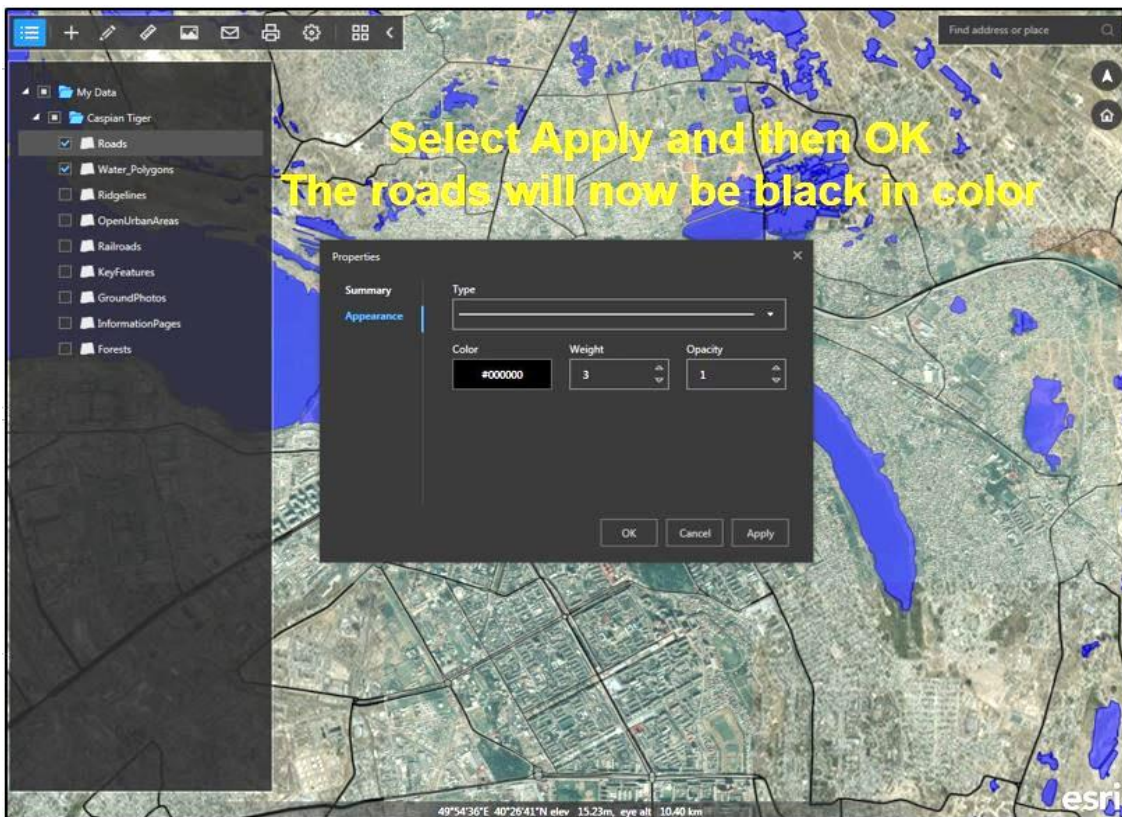


Figure 6: Video Demonstrating How To Use ArcGIS Earth for the Tactical Scenario

The formal curriculum will introduce concepts integral to geospatial engineering knowledge, such as spectral analysis. An example of change detection using both raster and vector data in ArcGIS will be introduced in the Fundamental Concepts of Geospatial Analysis block of the course. Figure 8 shows a geospatial product displayed in ArcGIS of change detection over a four-year period of a range complex.

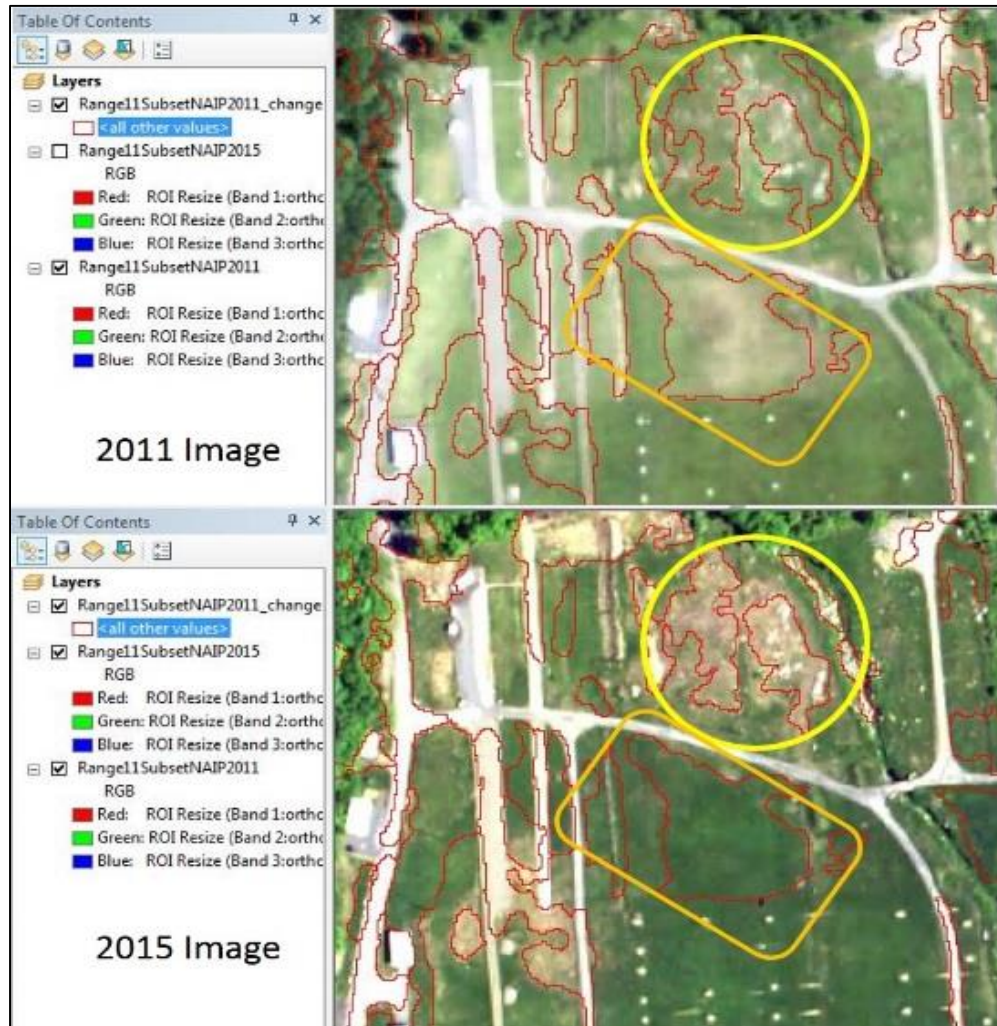


Figure 7: Change Detection Product in ArcGIS

### Gaining Terrain Expertise

Major Wendell Stevens, in a 2003 graduate thesis at the Army Command and General Staff College, stated "the expert understands the limits and capabilities of geospatial information and services and can integrate them into the appropriate tactical language and processes."<sup>8</sup> It is not expected that company grade officers will become technical geospatial experts or software specialists, but it is expected that they will possess a baseline expertise on the application of geospatial engineering. It is expected that students completing the course will be confident in their abilities to analyze how terrain can impact a tactical operation. It is also expected that this expertise can be applied when working within a brigade combat team, during a tactical exercise with partner services or nations, or with a federal agency such as the Federal Emergency Management Agency for disaster relief operations.



It is also expected that those completing the course are familiar with ESRI software, as every military service and several federal agencies use the software, and given that a recent survey by Worldwide Business Research determined that nearly 90 percent of all government and military agencies in Europe and the Americas use ESRI's ArcGIS as their primary geographic information system (GIS).<sup>9</sup>

### **Future Initiatives**

One of the major initiatives within the Engineer Regiment is developing a certification process for geospatial engineers. In the past, Army engineer officers could serve as a Topographic Engineer Officer. Typically an officer would attend several weeks of mapping, charting and geodesy training, earn an additional skill identifier. That form of certification ended almost two decades ago, but there has been a recent resurgence of geospatial engineering in the Engineer Regiment. There is a new skill identifier for Geospatial Engineer Officers (known as W2) and it was initially developed to track officer with prior geospatial engineering knowledge, either through an academic degree or specialized training. There has also been recognition in the Army engineer officer career map that highlights GIS Professional (GISP) certification. This is important for improving long-term professional competency, as in a recent survey more than two-thirds of GISPs agreed or strongly agreed that certification has contributed to their professional advancement.<sup>10</sup> Overall, it is expected that GETOC graduates will continue to use ESRI products and become more proficient as apps and online services become more commonplace.

Another area of interest is in understanding how UAVs are being integrated as a fundamental task in tactical operations, and getting that source of imagery into a geospatial work flow. In the future, it is expected that BCT Engineers be evaluated on the use of geospatial data for planning and operations during combat training center rotations, as well as how UAV data is used assessed, developed into geospatial products, and integrated into the Military Decision Making Process (MDMP). That will require providing the observers, controllers and/or trainers with a rubric to assess the tasks, specifically those focused on terrain analysis proficiency and expertise. This issue was identified as early as 1999, and continues to be assessed as an area where engineer staff officers require additional geospatial engineering knowledge.<sup>11</sup> It is expected that the combat training center evaluations will expand to the use of geospatial products for horizontal and vertical engineering projects assigned to construction battalions and companies during tactical operations.

The GETOC is a tactically-focused course that emphasizes geospatial engineering support to warfighters engage in land-based operations. It is designed to provide a fundamental understanding of geospatial engineering and common geospatial products developed using ESRI software. The course focuses on the application of geospatial information and products for tactical-level military operations. Moreover, the course is specifically designed for company-grade engineer officers to increase their geospatial knowledge, which increases tactical and terrain expertise. This is imperative because the Army expects engineers to be the terrain experts. Major Damian Green published an article in the Army Sustainment Professional Bulletin stating "Field Manual 3-34.170, Engineer Reconnaissance, reinforces the fact that geospatial engineering is an engineer capability in addition to combat (mobility, countermobility, and survivability) and general engineering skills."<sup>12</sup> That expectation and ultimately trust must be cultivated and developed by training in the classroom, on the computer, and during tactical operations, all of which are addressed in the GETOC.

## End Notes

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- <sup>1</sup> CPT Nicholas Cosmas, "Counter-mobility: Geographic Engineering?" Engineer Professional Bulletin, Volume 43, January-April 2013, 45.
- <sup>2</sup> FM 3-34, Engineer Operations, April 2014.
- <sup>3</sup> LTC Jared Ware, "Educating Geospatial Engineers for Tactical Operations," Engineer Professional Bulletin, Volume 44, January-April 2014, 51.
- <sup>4</sup> "Individual Training Plan for 12A Engineer Officer", United States Army Engineer School, 24 March 2014, 13.
- <sup>5</sup> FM 3-34.80, Geospatial Engineering, June 2014
- <sup>6</sup> McFarland, Stephen, "Distributed Common Ground System- Army System Training Plan (Version 1.0)," Central Army Registry, 6 November 2013.
- <sup>7</sup> "ArcGIS Provides New Dimensions for Looking at Data," ArcUser Spring 2016, Volume 19, Number 2, 6.
- <sup>8</sup> MAJ R. Wendell Stevens, "Enabling Engineer Officers as Terrain Experts," U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, 6 June 2003, 23.
- <sup>9</sup> Prates, Izabela, "National Defense Organizations Increasingly Rely on ESRI's ArcGIS," MundoGeo, 7 January 2015.
- <sup>10</sup> Adam J. Mathews & Thomas A. Wikle, "Assessing Professional Benefits of GIS Certification," Cartography and Geographic Information Science, 18 May 2016, 5.
- <sup>11</sup> CPT Shawn McGinley, "Assistant Brigade Engineer (ABE) Proficiency," CALL Newsletter 99-12, October 1999, 78-79.
- <sup>12</sup> MAJ Damian Green, "Terrain Analysis for Non-Engineers," Army Sustainment Professional Bulletin, Volume 43, Issue 1, January-February 2011, 18.

## Biography

Jared Ware is a Corps of Engineers officer in the United States Army. He currently serves in the Department of Geography and Environmental Engineering at the United States Military Academy at West Point, New York. He has operational military experience in mechanized, light, and airborne units. His most recent operational experience includes serving in command and primary staff positions in the 20th Engineer Brigade (Combat) and the 82nd Airborne Division at Fort Bragg, North Carolina. Prior teaching experience includes serving as an instructor of Advanced Geospatial Intelligence (AGI) at the National Geospatial-Intelligence Agency. He has earned previous awards from the United States Geospatial Intelligence Foundation (USGIF) and the Society of American Military Engineers (SAME). His research interests include GIS and remote sensing for disaster relief operations. Additional information is available at <http://www.usma.edu/gene/SitePages/Geospatial%20Curriculum.aspx>