2015 ISSUE 1

trajectory

THE MISSING PIECES

BIG DATA AND SUPERCOMPUTING DRIVE
A NEW ERA OF "ANTICIPATORY INTELLIGENCE"

trajectory

Military personnel supporting Operation United Assistance enter a U.S. Marine Corps MV-22 Osprey to depart Cesco City, Liberia. The U.S. Agency for International Development is the lead U.S. government organization for Operation United Assistance. U.S. Africa Command is supporting the effort by providing command and control, logistics, training, and engineering assets to contain the Ebola virus outbreak in West African nations.

U.S. ARMY PHOTO BY PFC. CRAIG PHILBRICK

Features

Cover image ©Getty Images/Gary Waters

TRAJECTORYMAGAZINE.COM

GEOINT AND EBOLA
Explore a collection of maps created to aid Ebola relief efforts.

BIG DATA TOOLS
Learn how the experts prefer to manage Big Data.

GOT GEOINT?
Read the first guest blog post from USGIF's new Innovation Task Force.

WE'RE ALL GEOINTERS

This year has certainly gotten off to an interesting start with regard to the weather in the Northeast United States. Of course, it has drawn just about everyone in the region to social media, the web, and television to examine maps supplemented by images from weather satellites and to try to predict the likely impact of the next big storm.

The public is routinely exposed to other examples of GEOINT, including the changing, amorphous blobs depicting the locations of ISIL in Syria and Iraq; ongoing challenges with Boko Haram in Nigeria and neighboring countries; and increasingly well-armed "separatists" who look remarkably similar to Russian military forces in Ukraine.

Anecdotally, I'm told there is a large map on the wall of one of our intelligence agencies titled "For Russian Soldiers." A bold red line traces the borders of Russia, with everything inside labeled "RUSSIA" and everything outside cross-hatched and labeled "NOT RUSSIA."

My point is that GEOINT continues to pervade our daily lives, making us all GEOINTers of sorts. Further, the combination of exciting advances in the world of geospatial information, remote sensing, and data science—along with rapid changes in other enablers such as data processing, storage, and transmission—have brought us to the brink of a GEOINT revolution.

USGIF's inaugural 2015 State of GEOINT report explores some of the implications of this coming GEOINT revolution. This report, which you may have received in the mail with this issue of *trajectory* or seen on the USGIF website, is a project we plan to produce annually. I hope the report will foster fruitful discussions about GEOINT tradecraft and the community's collective mission among our increasingly broad and diverse set of stakeholders.

In addition to the State of GEOINT report, this issue of *trajectory* contains a great article on the GEOINT contributions to the fight against Ebola in Western Africa; a look at how evolving data science is enabling predictive analytics; and an "op-ed" piece urging us all to pay requisite attention to the workforce of today—and tomorrow—as we aggressively pursue technological solutions to our vexing problems. Without an appropriately educated, trained, and prepared workforce, the community will not succeed, regardless of the power of our processors or the integration of our technical architectures and systems.

When the weather finally breaks, spring will bring new USGIF events and the launch of the Foundation's revamped membership program, including a new individual professional membership opportunity. I hope you'll consider joining and supporting USGIF, and our work on behalf of the entire GEOINT Community. After all, we're all GEOINTers—and USGIF is our professional society.

> **GEOINT continues to pervade our daily lives, making us all GEOINTers of sorts.**

KEITH J. MASBACK | CEO, USGIF
@geointer

Big Data Savant

Dozens of Special Ops missions in Iraq, Bosnia, and Kosovo give Mark Giaconia a unique perspective on Big Data Analytics.

Q: How does having *been there* influence your work?
I understand risk… because I lived it. That helps me anticipate which questions these massive data sets have to answer. One of my biggest motivators is getting the right data into the mix.

Q: In retrospect, what challenges stand out?
Not being able to share data with coalition partners was a huge frustration. That made it hard to collaborate — and cranked up the risk.

Q: How are you solving that problem today?
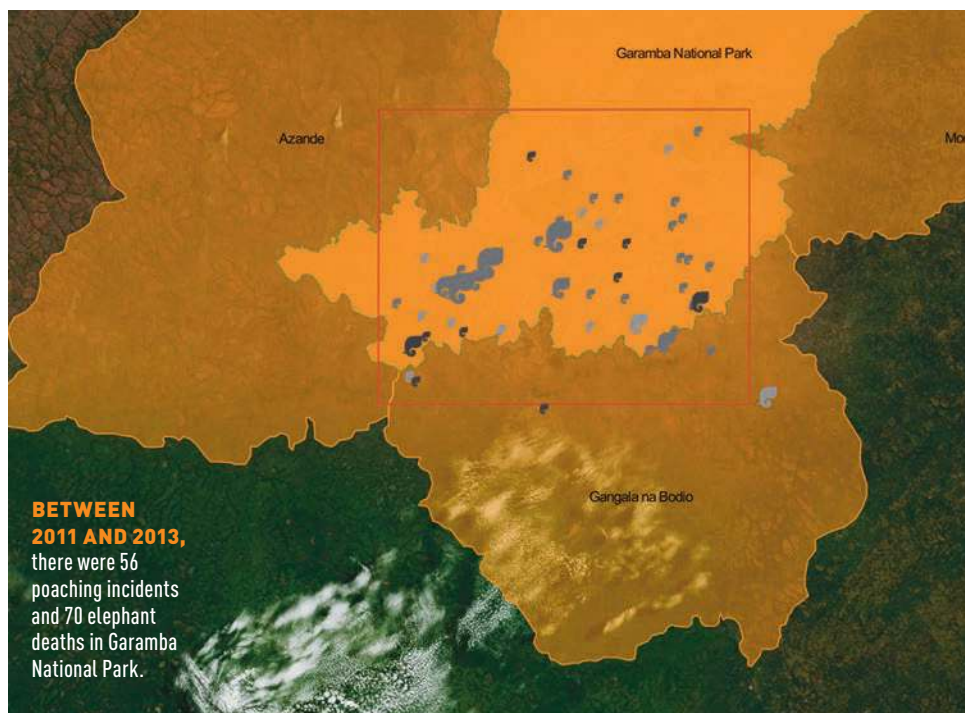It's all about using open source intelligence: blending multi-spectral imagery with unconventional data. I just developed an application that turned a livestream of tweets into geo-spatial intel.

Q: What USG mission are you serving?
I blend data to provide answers for intelligence analysts and military planners. My goal is to innovate *every* day and stay ahead of whatever GEOINT they need.

DigitalGlobe™

INTSIDER

NEWS UPDATES AND HIGHLIGHTS

BETWEEN 2011 AND 2013, there were 56 poaching incidents and 70 elephant deaths in Garamba National Park.

MAP IMAGERY COURTESY OF DIGITALGLOBE

DIGITALGLOBE AND SATELLITE SENTINEL TAKE ON POACHING

DigitalGlobe, African Parks, the Enough Project, and the Satellite Sentinel Project published a report titled "Poachers Without Borders" in January detailing how satellite imagery and predictive analytics are being applied to help park rangers fight illegal elephant poaching in the Democratic Republic of the Congo's Garamba National Park. According to the report, the African elephant population has declined more than 50 percent in the past 30 years as a result of poachers killing elephants for ivory and selling it on the black market. Rangers with limited resources face great danger when tracking poachers in the 4,920-square-foot park.

Collaborating with the Enough Project and African Parks, DigitalGlobe analysts were able to study data on locations where elephant remains were discovered, elephant collar data, ranger patrol routes, and locations of known poacher camps to conduct historical geospatial trend analysis, predictive analysis, and more. This research revealed areas of the park sharing similar geospatial characteristics with previous poaching sites—therefore areas where poaching is most likely to occur. As a result, there was a 98 percent reduction in the area of the park where poaching is likely to occur, with a 95 percent reduction in the area of the historical poaching zone.

The report is available for free online via the DigitalGlobe website and the initiative also includes an interactive website at **digitalglobe.com/interactive/garamba**.

NGA VISION FOR FUTURE ANALYTIC TECHNOLOGY

In November, NGA released its vision for the agency's analytic environment in 2020. The statement is intended to create a technology foundation for NGA's ongoing analytic transformation and to set the technology landscape for NGA intelligence analysis into the future.

The 12-page document says analysts in the future will need to "spend less time exploiting GEOINT primary sources and more time analyzing and understanding the activities, relationships, and patterns discovered from these sources." The vision also details the need for a unified GEOINT platform to provide interoperable tools, algorithms, and capabilities.

NGA says it will offer a number of opportunities for industry partners to provide feedback and recommend solutions based on the plan, including the new online GEOINT Solutions Marketplace, which allows industry to post capabilities and respond to business opportunities.

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Alaska is the only U.S. state with terrain data that is more than 50 years old.
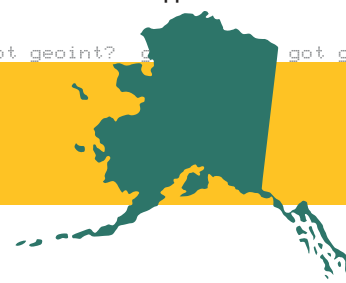
SOURCE: THE WASHINGTON POST

GLOBAL FISHING WATCH uses satellite data and mapping software to track large fishing vessels and help stop illegal fishing.

IMAGE COURTESY OF GLOBAL FISHING WATCH
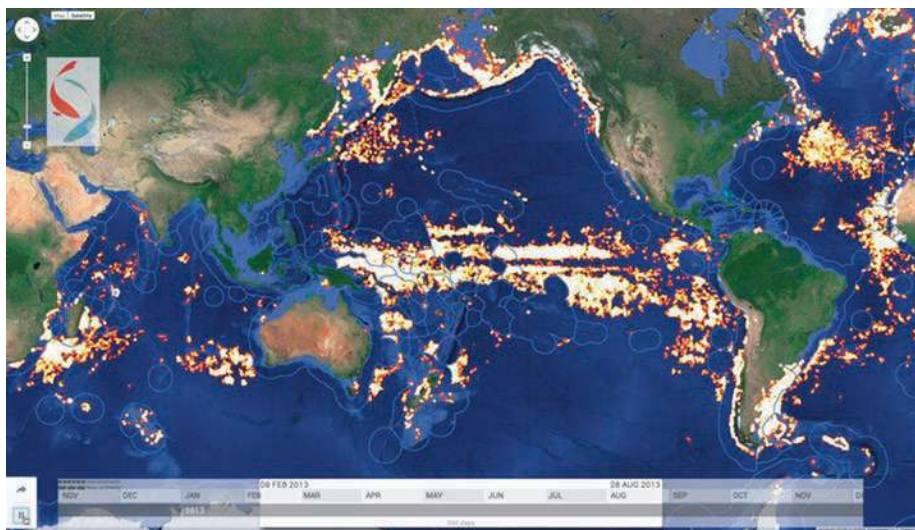
MAPPING ILLEGAL FISHING

Oceana, SkyTruth, Google, and SpaceQuest have partnered to combat illegal fishing by building the first global surveillance system that can track large fishing vessels anywhere in the world. A prototype of the system, called Global Fishing Watch, uses satellite data from SpaceQuest coupled with Google's mapping software and servers to display the tracks followed in 2012 and 2013 by approximately 25,000 ships that were either registered as large commercial fishers or were moving in ways that strongly suggest fishing activity. The project was led by Oceana, a marine conservation advocacy group, and the software was developed by SkyTruth, a small nonprofit specializing in the use of remote sensing technologies to map environmentally sensitive activities.

TASC AWARDED NGA APPS CONTRACT

TASC mobile applications offer mission support to deployed mobile users.

IMAGE COURTESY OF TASC

TASC was awarded a $25 million contract to serve as the National Geospatial-Intelligence Agency's (NGA) Application Operations Service Provider (AOSP). TASC will manage the business and technical aspects of soliciting, screening, and acquiring GEOINT applications. The AOSP program addresses NGA's need to acquire mobile, web, and desktop GEOINT applications. The contract has one base year with three one-year option periods. In other company news, Engility is set to acquire TASC in an all-stock deal worth $1.1 billion. The merger will create combined revenue of about $2.5 billion and employ around 11,000 employees. TASC will become a subsidiary of Engility and retain its current brand. The transaction was approved by the Boards of Directors of both companies and is expected to close in the first quarter of 2015.

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20,965 people enrolled in the first ever GEOINT Massive Open Online Course.

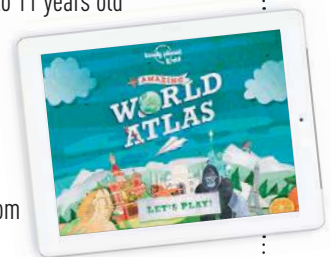SOURCE: PENNSYLVANIA STATE UNIVERSITY

GEOINT COMMUNITY WEEK OFFERS VARIETY FOR DEFENSE, INTELLIGENCE, AND HOMELAND SECURITY COMMUNITIES

Almost 1,500 registrants participated in more than 10 events Nov. 17-21 as part of USGIF's GEOINT Community Week (GCW). GCW is an annual week of geospatial-related activities and events designed to further collaboration among the defense, intelligence, and homeland security communities. Events were held in Northern Virginia, New York City, Gettysburg, Pa., and in other locations throughout the country.

This year, USGIF added several new items to the GCW agenda, including a Homeland Security and Defense Geospatial Community Exchange Nov. 20. The daylong exchange included keynote addresses from David Alexander, geospatial information officer and director of the DHS Geospatial Management Office; and retired U.S. Coast Guard Adm. Thad Allen. The event also included panel discussions on data and decision support, remote sensing, operations and coordinating structures, the geospatial cloud, and emerging technologies.

Additionally, USGIF partnered with the American Geographical Society for the society's inaugural "Geography 2050: Mounting an Expedition to the Future" event. Geography 2050, which took place Nov. 17 in New York City, explored the challenges civilization will face by the year 2050 through the lens of geography. Topics such as urbanization, climate, energy, expansion of the Internet, and other global trends encompassed the day's overarching theme: understanding how the world is changing and what can be done to better plan for the future. There were more than 20 speakers at Geography 2050 including National Geospatial-Intelligence Agency Director Robert Cardillo.

GCW also included a GEOINT Community job fair, multi-INT tradecraft community innovation exchange, GEOINTeraction Tuesday, an intelligence and national security panel discussion at Gettysburg College in Pennsylvania, and participation in GIS Day at George Mason University in Fairfax, Va., and the U.S. Air Force Academy in Colorado Springs, Colo.

USGIF ACCREDITS THREE NEW UNIVERSITY GEOINT PROGRAMS

USGIF announced the addition of Fayetteville State University, the University of South Carolina, and the University of Southern California to its growing list of USGIF-accredited geospatial intelligence programs. This brings the total to 12 colleges and universities with a USGIF accredited GEOINT certificate program, with several more schools in the pipeline.

Through the USGIF Academic Accreditation program, colleges and universities have the opportunity to receive accreditation of their geospatial intelligence programs accompanying a college degree. Students who meet high academic standards and graduate from accredited programs receive USGIF's GEOINT certificate, which helps ensure a robust workforce in the GEOINT Community. To date, 477 students have graduated with USGIF GEOINT certificates, with all but one school reporting its 2014 end-of-year graduates.

FOUR-TIME USGIF scholarship recipient Chris Lippitt hiking in California's Joshua Tree National Park in 2011.

SPOTLIGHT: USGIF SCHOLARSHIP RECIPIENT

Geographer Chris Lippitt won a USGIF scholarship not once, but four times— in 2005, 2007, 2008, and 2009—while he was a graduate and then doctoral student. This achievement leads one to ask, "What happened in 2006?" These USGIF scholarships supported the many research initiatives he undertook while pursuing his education.

Lippitt received a Ph.D. in geography from the joint program at San Diego State University and the University of California Santa Barbara in 2012, and previously achieved a bachelor's degree in geography and a master's degree in GIS science from Clark University in Massachusetts.

While pursuing his Ph.D., Lippitt founded the company TerraPan Labs, which works in collaboration with San Diego State University's Center for Earth Systems Analysis and Research and specializes in photogrammetry and remote sensing using UAVs.

Lippitt is currently an assistant professor with the University of New Mexico's department of geography and environmental studies, teaching remote sensing and GIS. He also remains an active board member with TerraPan Labs, which allows him to focus primarily on teaching and research.

"I enjoy the intellectual freedom of being at a research-driven university and teaching," Lippitt said. "It's nice to have one foot in both the private and education sectors, and have the two go with one another."

His current research consists of applying remote sensing to monitor hazard preparation and response within critical infrastructure spanning the biology, civil engineering, and geography disciplines.

From data to decisions

As world-class experts in geospatial-intelligence, Ball Aerospace transforms data into dynamic, predictive, interactive intelligence across all GEOINT missions and communities. From persistent data collection hardware to advanced processing and exploitation capabilities, we provide innovative, integrated solutions for the nation and our world.

Ball Aerospace & Technologies Corp.

**Agility to Innovate
Strength to Deliver**

www.ballaerospace.com

ADVANCING GEOINT TRADECRAFT

USGIF hosted a series of events Oct. 6-8, inviting GEOINT professionals to collaborate on a variety of the Foundation's professional development initiatives. USGIF gathered more than 60 individuals from academia, government, and industry to discuss academic accreditation, credentialing, and the state of GEOINT.

On Oct. 6, the Foundation focused on the USGIF collegiate accreditation program. Representatives from USGIF's 12 accredited colleges and universities discussed each school's successes and challenges within the program. This marked the first time USGIF gathered representatives from all of its accredited colleges and universities.

"The academic participants were able to socialize and learn about each other's strengths and challenges," said Dr. Maxwell Baber, USGIF's director of academic programs. "They saw they were not on their own island, but their challenges were actually quite common. USGIF learned what the schools' challenges were and how to more effectively support them."

On Oct. 7, more than 50 subject matter experts from across the GEOINT Community came together to lay the foundation for the USGIF State of GEOINT report. The inaugural report, polybagged with this issue of *trajectory*, compiles thought leadership and guidance on GEOINT topics that are "hot," "not," and "on the horizon."

USGIF concluded the series of events with a discussion Oct. 8 focused around the Foundation's plan to create a Universal GEOINT Credentialing program. This session explored lessons learned, best practices, and how USGIF's efforts might be integrated with existing geospatial certification processes.

"These three days allowed participants a wide variety of insights into the breadth and depth of the GEOINT profession," said Dr. Darryl Murdock, USGIF's vice president

USGIF FILE PHOTO

REPRESENTATIVES from academia, government, and industry brainstormed topics for USGIF's first State of GEOINT report.

of professional development. "We will all become more successful by leveraging our collective work and sharing best practices and great ideas. USGIF is committed and excited to continue working with each and every organization whose leadership is dedicated to fostering learning, professional development, and open communications."

PLENTY OF EYES IN THE SKY, NOT ENOUGH MINDS ON THE GROUND

As our nation faces ever-increasing national security threats, the U.S. Intelligence Community must address a workforce gap in remote sensing analysis

By Dr. Darryl Murdock, USGIF vice president of professional development

PHOTO COURTESY OF LOS ALAMOS NATIONAL LABORATORY

DANIELA MOODY is a postdoctoral fellow with the Intelligence and Space Research Division, Space and Remote Sensing Sciences at Los Alamos National Laboratory, N.M. Her team develops and applies remote sensing instrumentation, analysis, modeling, and machine learning to problems of national security and related sciences.

IN TODAY'S WORLD of light-speed satellite communications, advanced remote sensing, and supercomputers—and the mega-data they produce—we seldom think about who is applying all of this technology to meet our national security needs. It's easy to act as if all available data is put in one end of a computer with the necessary information emerging at the other end.

While the Intelligence Community improves the technology needed to interpret this high volume of data and information, the sheer volume of data being consistently collected around the world mutes our existing analytic capability. At the intersection of technology and human intelligence are the GEOINT analysts who pore over the data retrieved by our increasingly sophisticated remote sensing technologies, assign the data context, and create actionable knowledge. GEOINT analysts regularly apply their skills to

multiple national and international threat scenarios, military operations, and natural and manmade disasters. Without these dedicated GEOINT analysts we would have eyes (in the form of satellites and UAVs) on our tumultuous world but would not understand what the images they produce mean.

The Intelligence Community faces a rising demand for highly trained geospatial and remote sensing analysts. At a time of burgeoning and

unprecedented threats including terrorism, asymmetrical warfare, and social unrest across the globe, the GEOINT Community is especially challenged as its workforce ages at a rate much faster than qualified analysts enter the workforce. Steps should be taken immediately to address this widening GEOINT analyst gap. Further delay will only make this current staffing problem more difficult and costly to address in the future.

> Steps should be taken immediately to address this widening GEOINT analyst gap. Further delay will only make this current staffing problem more difficult and costly to address in the future.

AIRMAN 1ST CLASS
Melissa Beecher uses a combat mission plotter to diagram enemy threats on a map. Beecher is assigned to the 48th Rescue Squadron as an intelligence analyst.
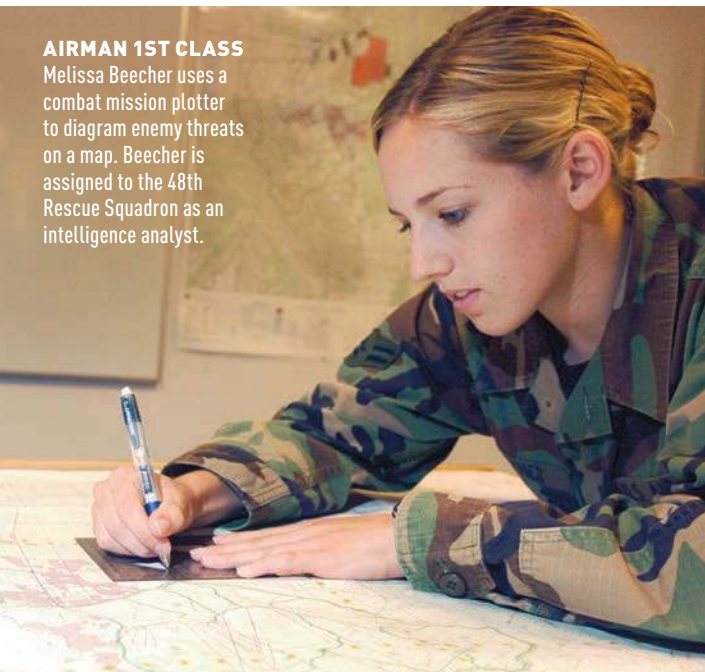
HISTORICAL PRECEDENT

The problem is simple to explain. In the aftermath of World War II and with the onset of the Cold War, the United States realized the pressing need for intelligence gathering. Aerospace and satellite technology developed in the '50s and early '60s gave the U.S. the necessary tools for this effort. Addressing the need for a highly skilled aerospace and intelligence analyst workforce, Congress passed the National Defense Education Act in 1958. The act provided U.S. universities with resources to improve technical education and graduate programs in order to produce an engineering workforce for the aerospace and intelligence gathering units of the federal government and commercial industry. This workforce was developed to observe and—more importantly—interpret the data that was just becoming available.

These first generations of intelligence analysts did a superb job during the Cold War and subsequently developed many of the remote sensing methods and technologies still used today. However, a large number of these pioneering geospatial analysts are heading into retirement and are not being replaced at a rate sufficient to bridge the mission performance gap.

A 2013 report by the National Academy of Sciences on the Future U.S. Workforce for Geospatial Intelligence claims qualified "GIS and remote sensing recruits are already hard to find." It concluded that the nation needs to ensure an environment exists to create a STEM workforce trained specifically in remote sensing—with remote sensing being identified by the academy as one of the "five core areas on which the current production and analysis of geospatial intelligence relies." An earlier report by the House Permanent Select Committee on Intelligence came to the same conclusion with respect to the projected analyst gap and recommended the U.S. government partner with universities to prepare more students for space and remote sensing analysis careers.

Positioning universities to produce more GEOINT engineers and remote sensing analysts is a national security imperative. A new national strategy is needed to ensure the health of U.S. GEOINT analyst education. However, any amendments to the National Defense Education Act to recognize the modern challenges facing the GEOINT Community and our universities would require substantial financial support.

44
PERCENT OF 2013 U.S. HIGH SCHOOL GRADUATES ARE READY FOR COLLEGE-LEVEL MATH.

19
THE NUMBER OF INDUSTRIALIZED NATIONS IN 2012 WHOSE HIGH SCHOOL STUDENTS PERFORMED BETTER THAN U.S. STUDENTS IN SCIENCE.

SOURCE: NMS.ORG

Universities should be incentivized, as was done in the '50s, to greatly expand education and training programs and work with NGA and other U.S. intelligence agencies.

STEM-TO-GEOINT

At USGIF, we strongly believe, given the current state of global security, that maintaining and expanding our nation's GEOINT capabilities is critical—and addressing the GEOINT analyst workforce shortage is essential to doing so. We support the strengthening of the strategic relationship between the U.S. defense and intelligence communities and the U.S. academic community, particularly in STEM disciplines focused on addressing the technical collection and analysis efforts required by our nation.

To that end, I am in favor of a STEM-to-remote sensing pilot program focused on doubling the number of remote sensing analysts entering the Department of Defense and Intelligence Community within the next five years. This program could include tuition funding for up to four years, be open to both undergraduate and graduate students, and offer funded summer internships with industry, during which exposure to and work on hard problems should be the focus. All selected participants should also receive security clearance during their second program year, which would allow them to work within government facilities and on classified projects at their home school. When shown to be successful, such a program could be expanded to other geospatial intelligence sub-disciplines to develop cross-cutting, broad-based GEOINT analysts capable of producing finished intelligence products derived from a combination of remotely-sensed data, geographic information systems data, and open-source information.

Though some may argue such an initiative is not possible, similar programs have already been established in pockets around the globe. As our nation's needs and priorities change, a STEM-to-remote sensing program could become a STEM-to-GEOINT program, which would include a strong and flexible remote sensing component. ◼

LEVERAGING OPEN-SOURCE TOOLS TO STRENGTHEN INNOVATION

New task force to help GEOINT Community share technology and ideas

INNOVATION IS AN INTEGRAL PART of USGIF and one of its three mission pillars: build the community, advance the tradecraft, and accelerate innovation. But innovation is not only important to USGIF, it is vital to the GEOINT Community—it's what makes the community push the envelope to create better information and insight for decision-makers.

USGIF's Innovation Task Force formed in mid-2014 to help bolster innovation across the GEOINT Community. As its name suggests, the group aims to strengthen the Foundation's mission through various activities and events designed to share innovative ideas and speed up technology adoption. As a USGIF task force, the members aim to execute specific goals within a one-year time period.

"Innovation has always been at the heart of the GEOINT Community, and is integral to one of the three pillars of the USGIF mission," said USGIF CEO Keith Masback. "Because innovation is complex, it's important to have a task force solely dedicated to exploring future concepts and creating a pathway for emerging commercial technologies to enter the government acquisition stream. I anticipate this task force will make great strides on behalf of the entire community."

Innovation Task Force co-chairs Abe Usher, chief technology officer of HumanGeo, and AJ Clark, president of Thermopylae Sciences and Technology, said there is more room to develop innovative opportunities in the GEOINT Community.

Usher said the task force is brainstorming nontraditional methods for hurdling challenges that often prevent innovation from moving forward. One such method is to encourage the use of sharing and showcase open-source technology. Clark said GitHub, a website where programmers can share and store code, is one resource the task force believes could help support collaboration and innovation among GEOINTers.

"We want to promote awareness of those [open-source] technologies and expose new generations of developers to the GEOINT Community by building on [the technology] and seeing the functionality and analysis available," Clark said.

Jessica King, HumanGeo vice president of intelligence operations and a member of the Innovation Task Force, said today's ever-changing competitive landscape cultivates innovation at a new level.

"It's time to narrow that focus to create a task force centered on new, emerging trends that can be applicable to the value of the GEOINT mission of—just as National Geospatial-Intelligence Agency Director Robert Cardillo's intent states—'conveying consequence,'" King said.

The task force aims to host quarterly events featuring promising capabilities, open-source software, and open data. Potential event ideas include an interactive challenge for geospatial developers and engineers as well as demonstrations hosted by USGIF members ranging in topics from cloud computing to UAVs.

Through its initiatives, the Innovation Task Force hopes to provide reference data sets and deliver updates to engineers, analysts, and researchers to help them describe their technical capabilities to the broader GEOINT Community. Additionally, the task force plans to provide in-person quarterly briefings on the state of commercial, academic, and government innovation in geospatial technology to senior leaders within the Intelligence Community.

"If innovation is everyone's shared role and responsibility, nothing will actually take place," Usher said. "By standing up a task force with assigned responsibilities, we enhance the likelihood that things will get done." ▪ BY LINDSAY TILTON MITCHELL

> "IF INNOVATION IS EVERYONE'S SHARED ROLE AND RESPONSIBILITY, NOTHING WILL ACTUALLY TAKE PLACE. BY STANDING UP A TASK FORCE WITH ASSIGNED RESPONSIBILITIES, WE ENHANCE THE LIKELIHOOD THAT THINGS WILL GET DONE."

—Abe Usher, Innovation Task Force co-chair

AN
UNPRECEDENT
RESPONSE

BY KRISTIN QUINN

When the American Red Cross first arrived in West Africa to assist with the 2014 Ebola epidemic, the organization was literally faced with an empty slate.

"The original map we were looking at for West Africa was almost blank," said Dale Kunce, a senior geospatial engineer and GIS team lead for the Red Cross. "You didn't just not know where the buildings were, you didn't know where the towns were, where the roads were, what roads connected which towns. If a patient at a treatment center said they were from whatever hamlet, you didn't know where that was."

Today, thanks in large part to Open-StreetMap (OSM) data, when a patient names their village or hamlet, health officials and aid workers have the resources to quickly determine not only where the village is located, but the number of homes and general population of the village, as well as which route the patient most likely traveled to reach treatment. This information helps pinpoint which locations are most at risk and therefore in need of education campaigns and contact tracing—following up each day for 21 days (the Ebola incubation period) with people who have been in contact with an Ebola patient.

In OSM, the state of California has more mapping content than the entire African continent, according to Kevin Bullock, a product manager at Digital-Globe overseeing base map products, and also an OSM contributor and advocate.

"Mapping data outside of the U.S. and Europe is inadequate," Bullock said. "Mapmaking companies have invested in building out map data in developed countries. The degradation of that data is quite steady as you move away from developed areas. Maps of areas in Africa and Southeast Asia are inadequate and not actionable, especially for humanitarian missions … It's like giving a UPS driver 1,000 packages to deliver in Manhattan without any addresses or locations and saying 'good luck.'"

In the wake of the West African Ebola epidemic that emerged in 2014, the geospatial community has addressed these extreme obstacles by deploying satellite imagery, crowdsourced crisis mapping programs, and GIS software and training to get updated maps and data into the hands of local officials, as well as the range of military, health,

and humanitarian personnel that have descended upon the region.

Geospatial tools have been applied in the Ebola response effort for many mission sets:

■ For triage and determining where to stand up Ebola treatment units (ETUs) and community care centers (CCCs);
■ To monitor and share the locations of various non-governmental organizations (NGOs) deployed to West Africa;
■ To help government and aid organizations transport supplies and patients efficiently;
■ To map dwellings for door-to-door

ED

THE GEOINT COMMUNITY'S ROLE IN THE EBOLA RELIEF EFFORT REPRESENTS A SWEEPING SHIFT IN HOW THE WORLD ACCESSES AND APPLIES GEOSPATIAL TECHNOLOGY.

PHOTO BY SGT. 1ST CLASS BRIEN VORHEES, 55TH SIGNAL COMPANY

wellness checks, quarantines, and contact tracing;

■ To understand the disease's epidemiology—the study of the distribution and determinants of health states or events;

■ To plot the locations of corpses;

■ To understand the human geography and sociocultural issues affecting the spread of Ebola through the region, and;

■ To anticipate where the disease might spread.

Not only has the Ebola outbreak been uniquely challenging as a result of the size of the affected area, the disease's potential to spread globally, and the

duration of the crisis, but the geospatial community's response has also been unprecedented in many ways. The number of volunteers involved, the amount of publicly available data, and the level of collaboration being achieved across federal agencies, national governments, academia, and NGOs have all soared beyond that of more static crises.

LAYING THE FOUNDATION
When the Ebola epidemic first gained global attention in spring 2014, Digital-Globe combed its 15-year commercial imagery archive to provide images of the

affected area and began training its satellites on the region more often.

Satellite imagery and map layers serve as the foundation necessary to enable exquisite analysis in underdeveloped areas according to Todd M. Bacastow, director of insight product management for DigitalGlobe. The imagery provides a quick-start for volunteers to trace roads and buildings then later incorporate human geography data to begin recognizing patterns in and making predictions from the data.

"Unless you have foundational map data you can't perform the analysis

^ A local worker walks past rows of boots and aprons drying in the sun after being decontaminated at an active Ebola Treatment Unit built as part of Operation United Assistance in Suakoko, Liberia, Nov. 22, 2014.

required to answer complex questions," Bacastow said.

The use of geospatial data in epidemiology is nothing new; the technology has just become more sophisticated. The London Cholera epidemic of 1854 was halted after health officials plotted patient residences on a map and traced the disease to a lone water pump.

"DigitalGlobe has been collecting imagery in West Africa for longer than three years not knowing there was going to be a health crisis," Bullock said. "We were able to go into our archive and publish actionable, relevant imagery. It's very powerful when put into the hands of the crowd because entire villages, cities, provinces, and countries can be mapped within hours."

Although government and military personnel can gain access to DigitalGlobe's imagery and human geography data of West Africa through the National Geospatial-Intelligence Agency's (NGA) EnhancedView program, the company's partnership with software provider Mapbox has helped it provide that same imagery to the volunteer Humanitarian OpenStreetMap Team (HOT), which uses volunteer crisis mappers from around the world to develop crowdsourced maps. A scalable Mapbox platform linked to OSM creates

a pipeline to process DigitalGlobe imagery and publish it on the laptops, tablets, and smartphones of the HOT volunteers who trace the images to create updated maps.

"When OpenStreetMap contributors log in they expect access to satellite imagery, almost like we expect electricity to work," Bullock said. "But it actually takes a lot of time and investment to unlock that for them."

The Ebola relief effort has been the largest undertaking yet for HOT by all measures (*Editor's note*: HOT declined to be interviewed for this article). Since March 2014, more than 2,500 volunteers from around the world have mapped more than 12 million objects in Sierra Leone, Liberia, and Guinea, including around 33,000 place names, more than 100,000 kilometers of roads, and 750,000 buildings. HOT products are helping Doctors Without Borders (Medecins Sans Frontieres), the Red Cross, and other NGOs carry out their Ebola relief missions in West Africa.

Kunce said the Red Cross and other humanitarian organizations wouldn't be as effective in their missions without the contributions of companies such as DigitalGlobe and Mapbox.

"The Red Cross cannot afford a satellite nor would people want us to

buy a satellite because the U.S. citizens have already paid for them," Kunce said. "[They've] already paid for the imagery, so being able to use that for humanitarian purposes is amazing."

But the reach of OSM has grown beyond NGOs since the crowdsourcing platform gained credibility in the aftermath of the 2010 Haiti earthquake. Michael Wellman, a geospatial analyst with the U.S. Centers for Disease Control and Prevention (CDC), said the agency has made significant use of OSM throughout the Ebola crisis.

However, Wellman said the agency is cautious about the veracity of crowdsourced data and has encountered many discrepancies in the range of data sets built during the Ebola response. For example, his team might use satellite imagery to clear up conflicting data on the location of ETUs or villages with the same name (which he said is quite common in the region). The CDC Situational Awareness Team also relies on personnel in the field to confirm information.

"They're verifying and validating what OSM contributors are doing so we can provide up-to-date maps for our deployers—people running samples to labs—so they know what's the route I need to take to get there? Is it passable? What's the status and quality of the road?" Wellman said.

All CDC personnel in the field take GPS devices with them to send back coordinates of new places that need to be mapped as well as to map the conditions of roads, many of which are actually dirt motorcycle paths. Wellman said one team, encountering some terribly muddy roads, plotted GPS points for every place they got stuck in order to prevent others from taking the same routes. In another example, Wellman received an email on Thanksgiving Day from a team in Liberia desperately seeking help to map the area around a village where residents had fled an Ebola outbreak. After the team sent GPS coordinates, geospatial analysts were able to promptly email them a map.

Kunce described the adoption of OSM by government agencies and the U.S. military, as "overwhelming." OSM is even the base layer for NGA's public-facing Ebola response website.

A DIGITALGLOBE WorldView-2 satellite image of Monrovia, Liberia, taken April 8, 2014, is overlaid with DigitalGlobe landscape and human data set features.

CHANGING THE GAME

The popularity of NGA's public Ebola data has far exceeded that of its restricted information. As a result, Tim Peplaw, director of NGA's Readiness Response and Recovery Office, said the Ebola relief effort has presented many lessons learned for the agency.

"Generally when we handle a disaster it's a relatively small area on the ground, such as in the event of an earthquake or flood," Peplaw said.

His office is responsible for providing unclassified GEOINT products for humanitarian crises. In response to the Ebola crisis, NGA stood up a public-facing website using Esri's ArcGIS online, which Peplaw said can handle unpredictable surges in web traffic and constantly refresh data as situations on the ground evolve.

"[ArcGIS Online] caters to multiple audiences," Peplaw said. "You don't have to be a well-versed GIS user in order to understand how to turn on and off the different layers … users have the ability to control and build their own common operating picture."

NGA is also providing an unclassified, but password protected website as well as a classified website for Ebola data. But in a speech NGA Director Robert Cardillo gave at the Geography 2050 conference in New York City Nov. 19, he lauded the success of the public website.

"It's been an unprecedented experience for NGA, with important lessons that will inform our efforts to provide public-facing geospatial content in the future," Cardillo said.

As of Feb. 10, NGA's public Ebola website included 495 data layers, 202 products, 68 applications, and 100 percent of its unrestricted elevation data. Since Oct. 23, the site had been viewed more than one million times.

"It shows there's a high demand for this type of information among nontraditional customers, including volunteers, health workers, and NGOs," Cardillo said. … "It's a frank reminder we need to do all we can to provide our data, knowledge, and services at the lowest classification possible, in order to provide context for our customers."

As a result, Peplaw's office is working with NGA general counsel to move as

much data down to the public website as possible and to make the data not just accessible, but downloadable.

"This is different than anything we've ever done before in the unclassified realm," Peplaw said.

MISSING MAPS

The lack of adequate maps of West African countries when the Ebola epidemic began highlighted the global humanitarian community's extreme need to preemptively map the world's most vulnerable populations and regions, according to Dale Kunce, a senior geospatial engineer and GIS team lead for the American Red Cross.

Although Kunce describes the collaborative and open-source mapping efforts that have taken place since spring 2014 as nothing short of amazing, he can't help but wonder how different the outcome might have been with better geospatial information available at the outset of the crisis.

"We were mapping so much, but what if we'd built up the mapping infrastructure [beforehand] so that we could have more effectively deployed those teams?" Kunce said. "Does that mean one life or 100 would have been better? I don't know, but it could've made a huge difference."

To address this need, the American Red Cross, in coordination with the Humanitarian OpenStreetMap Team (HOT), reached out to the British Red Cross and Doctors Without Borders (Medecins Sans Frontieres) to create the Missing Maps project. The project's objectives are to map the most vulnerable places in the developing world, as well as to support HOT in developing new technologies, workflows, and communities.

The U.S. State Department is also working to build communities around OSM through its MapGive and Imagery to the Crowd initiatives, but Missing Maps is unique in that it's a collaborative effort by and for non-governmental organizations (NGOs).

"The goal of [these initiatives] is this growing network and movement around creating the best map of the world in OSM because the uses and applications are limitless and add real value in the critical, lifesaving context," said Benson Wilder, a geographer and analyst with the State Department's Humanitarian Information Unit.

In its first year, Missing Maps will actively seek additional partnerships among NGOs and individuals interested in being open data and software advocates.

"The Red Cross is not going to be able to map the entire world by ourselves nor do we want to," Kunce said. "We are openly seeking new organizations to join us in our efforts to help map the world's vulnerable places before disaster."

Map of Faranah, Guinea, pre-Ebola response.
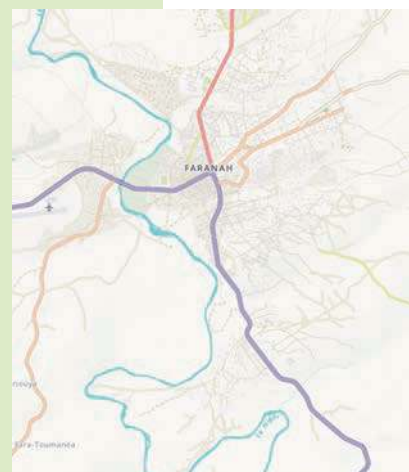
Map of Faranah today, after the activation of Humanitarian OpenStreetMap Team (HOT) volunteers.

IMAGES COURTESY OF THE AMERICAN RED CROSS

HUMAN GEOGRAPHY

In addition to satellite imagery, Digital-Globe has also provided detailed human geography data to government agencies and humanitarian relief organizations, offering a better understanding on

potential points of disease transmission and to help identify which populations are most at risk. NGA tapped Digital-Globe to provide human geography layers of affected West African countries alongside the commercial imagery available on the agency's public Ebola website. Co-registered imagery and human geography layers enable monitoring of demographics, critical infrastructure, economies, ethnicities, education levels, environment, medical facilities, and local events.

"These equip the global relief community with robust and exploitable foundation GEOINT that clearly takes us beyond the pixel into the next realm of responsiveness," said Christopher Incardona, DigitalGlobe's senior director of government programs–NGA.

Much like London's Cholera outbreak was tied to patterns of behavior among patients who used the infected water pump, sociocultural and demographic information remains essential to enable responsiveness in modern health crises.

NGA works to get this data into the hands of those who need it most through its partnership with the U.S. State Department on the Worldwide Human Geography Data (WWHGD) Work Group. The working group, launched in 2011, builds voluntary partnerships around human geography data and mapping to promote human security.

"One of the main contributions we got from the outside world, even before the public-facing website was established, was due to a terrific response from a data cell in the [WWHGD]," Cardillo said.

Ashley Moran, associate director of the University of Texas at Austin's Robert Strauss Center for International Security and Law and a member of the WWHGD, said the group has been a valuable network for collaboration. With the help of the working group, the Strauss Center leverages geospatial technology to integrate various data sets related to security in West Africa.

Kevin Hughes, a GIS enthusiast and WWHGD member, expressed frustration that many people still don't understand how ubiquitous GIS is in developed countries.

"It's kind of like saying the Internet is [only] for email," Hughes said. "When you look at GIS now, it's embedded in every element of modern society."

Hughes hopes resources being poured into West Africa will emerge as a silver lining to the Ebola epidemic, and said GIS has the potential to help these nations advance in terms of civil order and capacity for critical infrastructure, property boundaries, first responder networks, and more.

Moran said in order to help developing countries in the long term, it's essential for organizations such as those involved in the WWHGD to focus on building local capacity through training and the augmentation of platforms already in place. The Strauss Center has partnered with iLab Liberia, a nonprofit computer lab providing access to cutting-edge technology and IT assistance to leverage technology for the good of the country. iLab frequently hosts free training and tech events.

"There are local organizations with incredible geospatial tools in place that might just need to be supercharged to respond to this crisis," Moran said.

This is a message the U.S. Army and NGA have paid close attention to as well.

CAPACITY BUILDING

Barry Miller is an NGA analyst deployed to Liberia with the U.S. Army 101st Airborne Division, which was sent to the country to help build ETUs and CCCs. Miller works with analysts from the Liberian Institute of Statistics-Geo-Information Services (LISGIS), the primary provider of geospatial products to not only the Liberian government, but to the United Nations and all NGOs supporting the Ebola relief effort. Miller helps Liberian analysts couple their local knowledge with unclassified imagery to map areas hardest hit by the epidemic, visualize medical and transportation infrastructure, and determine the best locations for helicopter landing zones and standing up ETUs and CCCs.

Miller and the 101st GEOINT team created a Google Earth Common Operational Picture of the response mission, which is replicated on the All Partners Access Network and is available across the U.S. Department of Defense (DoD) and among organizations without access to traditional DoD networks. They also work with the Liberian Ministry of Health to visualize its data and create overall count, infection rate, and density maps on the number of probably, suspected, or confirmed cases of Ebola throughout Liberia. Miller emphasized that the Liberian public is also reliant upon LISGIS data.

"It's critical to show status updates of ETUs so the Liberian people know where to go to get help," Miller said, adding that up-to-date road conditions also help patients determine the best route for traveling to a facility.

Miller is confident GEOINT has helped mitigate the spread of Ebola in West Africa.

"We've actually seen a significant number drop over here and with GEOINT we've been able to publish and disseminate that information to other organizations so they're able to see how the numbers have dropped and where," he said.

> ## "One team, encountering some terribly muddy roads, plotted GPS points for every place they got stuck in order to prevent others from taking the same routes."
>
> — Michael Wellman, geospatial analyst, U.S. Centers for Disease Control and Prevention

Perhaps most importantly, the 101st has provided more than 200 hours of GEOINT mentoring and training to LISGIS that will benefit the country long after the epidemic subsides. This includes embedding an analyst with LISGIS daily, studying LISGIS analysts to provide process improvement suggestions, and weekly, five-hour Saturday classes at LISGIS headquarters.

"The partnership between the 101st Airborne Division and NGA with LISGIS has been very productive and beneficial for both parties," said Cpl. Christopher Byers, a GEOINT specialist with the 101st. "As LISGIS becomes better at their analysis and production, they will be able to shoulder more of the geospatial requirements related to the Ebola fight."

The Urban and Regional Information Systems Association's (URISA) GIS Corps, which matches volunteer GIS experts with NGO needs, focuses on capacity building by offering assistance and training to nonprofits that cannot afford to hire GIS professionals.

In December, the Corps was interviewing volunteers for its third Ebola response project with the United Nations' World Health Organization (WHO), which had requested six volunteers in total: five to be deployed to Ghana, Sierra Leone, Guinea, Liberia, and Geneva, Switzerland; and one to work remotely.

"This project is about getting our technology on the ground for 30 to 45 days because [WHO] doesn't have anyone who knows GIS in their offices," said Shoreh Elhami, GIS Corps co-founder.

Like NGA, WHO is also working in Esri's ArcGIS Online platform for its ability to cater to even the most novice GIS users. Elhami said all five deploying volunteers must be well versed in the platform and that Esri offered to provide additional training to volunteers immediately before deployment. The aim is for volunteers to pass this knowledge on to WHO personnel in country.

The World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) has stood up an Ebola GeoNode with capacity building in mind, according to Benson Wilder, a geographer and analyst with the U.S. State Department's Humanitarian

Information Unit (HIU), which partnered with GFDRR on the project. The goal of the Ebola GeoNode is to provide open, well-curated spatial data and metadata that can be accessed in an environment enabling quick visualization and analysis.

"There's a mind toward longer term management of the geospatial data and the ability to transfer the content and the governance to entities who will have an interest in using it and keeping it up to date," Wilder said. "The best map is going to be made by the people who live there."

However, Wilder added, in the midst of Ebola it's been challenging to build up a strong community of local contributors.

But as the epidemic subsides, the data will only become more powerful if it is available in the long term and locals continue to map, according to Kunce.

"They will be able to advocate on their own behalf because they will have data about themselves," Kunce said.

WHAT'S NEXT?

Although the potential uses of the new geospatial data born out of this crisis are promising, the ongoing epidemic and threat of transmission is still acute. The Ebola epidemic has begun to slowly taper, and the CDC is working vigilantly through the application of modeling to maintain and speed up this course.

"We are taking data of the distance between districts and the cases among districts to look at the likelihood of the virus moving to adjoining districts

beyond where is already affected," said Jacqueline Burkholder, a medical epidemiologist with the CDC's Situational Awareness Team.

Meanwhile, more ETUs and other medical facilities are being built in the field and will need mapped, Digital-Globe continues to snap images of the region, NGA continues to update its public-facing website, and volunteer and professional mappers alike update the ever-changing data to reflect the real-time situation on the ground.

Stakeholders in the geospatial community should consider how to apply the significant lessons already learned. How will HOT maintain engagement with its new influx of volunteer mappers and utilize them in future crises? How will the advent of OSM and similar open-source platforms change the way the federal government responds to crises?

And how will NGA and other federal agencies learn from the success of NGA's unparalleled public Ebola website? This is a question NGA Director Cardillo has already begun to ponder.

"In the future, [West Africans] will be able to use their new content and techniques well beyond the current crisis to build a modern geospatial database about their country for a future census and future elections," Cardillo said during his Geography 2050 address. "While we've posted our context on the World Wide Web, we have much to learn, because this will be more and more common, and more and more necessary." ▪

CHIEF WARRANT OFFICER 2 Angel Mitre (right) explains to personnel from the Liberian Institute of Statistics–Geo-Information Services (LISGIS) how exchanges of geospatial data create a more robust, useful product for organizations supporting Ebola relief. Mitre's team is assisting, mentoring, and training LISGIS. *From left to right: Kayloe Frank, LISGIS technician; Cpl. Christopher Byers, geospatial information services mentor; James Barzon, LISGIS technician; Andy Tugbah, LISGIS technician; and Barry Miller, NGA geospatial intelligence analyst.*

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the mi

ssing
pieces

BY MELANIE D.G. KAPLAN

THE ADVENT OF **BIG DATA AND SUPERCOMPUTING** IS DRIVING A NEW ERA OF "ANTICIPATORY INTELLIGENCE," BUT HOW WILL THE APPLICATION OF THESE TOOLS FIT INTO THE TRADITIONAL IC CULTURE?

During the Cold War, the Intelligence Community collected information about Soviet activity: The enemy is loading ammunition; it's moving artillery closer to maneuver forces. The observations were logistical, and the data yielded warnings, explained Collin Agee, U.S. Army senior adviser for Intelligence Community engagement. "Predictive analytics" might be the buzzphrase du jour, Agee said, but the concept is nothing new. In the commercial realm, predictive analytics is picking up steam, while the Intelligence Community is adapting the concept to modern computing technology and Big Data, and simultaneously shifting the nomenclature toward "anticipatory intelligence."

ILLUSTRATION © GETTY IMAGES/GARY WATERS

"Predictive intelligence is deterministic—'Are the Soviets going to attack?'" Agee said, adding that anticipatory intelligence is a better match for today's less-defined enemy. "Anticipatory is when you don't know what the end game is. It's more cognitive and more sophisticated."

Big Data, supercomputing, and sophisticated algorithms allow us to process more information than ever before, but the real power is in identifying anomalies—the black sheep in the data.

"It's things that are unpredictable but can have catastrophic events," Agee said. "How silly does it sound to say people are going to fly planes into skyscrapers?"

Today's anticipatory intelligence capabilities likely could have, as Agee said, connected the 9/11 terrorists to one another and generated an alert—present-day capabilities could have connected the dots.

But the number of dots is dizzying. According to David Bray, a visiting associate in cybersecurity and culture at the University of Oxford, the amount of global digital data doubles every two years. With six billion terabytes of data available in 2014, that number is projected to reach 96 billion terabytes by 2022, Bray said.

Behind predictive analytics is the notion that everything, from a shopper's habits to a tumor's growth to an aircraft engine's performance, is predictable. Data can now predict which day is best to buy airline tickets, when a drought will happen, and where the next social uprising might occur.

"Any mathematician will tell you the more factors you have, the better model you'll build," said Kirk Borne, data scientist and professor of astrophysics and computational science at George Mason University. "If all I have is a person's name, I won't know if someone will commit a terrorist act. But if I know their connections and the crazy things they're saying on Twitter, all that extra contextual information makes a more accurate and predictive model."

Predictive analytics applies modeling, data mining, and machine learning, and is also based on the assumption that the past informs the future. Businesses and organizations use exhaustive amounts of historic information to shed light on future actions, events, opportunities, and risks—from identifying casino cheaters in real time to predicting which customers are about to switch banking institutions—and then preventing the defection.

While commercial industries have embraced predictive analytics, the defense and Intelligence Community—which yearns for clues about tomorrow—is often eschewing the word "predictive" to strive for analysis methods it considers even more complex.

Kevin O'Connell, president and CEO of Innovative Analytics and Training, who also teaches at Georgetown University's Center for Security Studies, echoed Agee's statements. O'Connell said "predictive" implies a single-point outcome, such as whether someone is going to buy apples or oranges. In the Intelligence Community, it's all about anticipation.

"Historically, thinking about the future meant experts picked a small number of future scenarios, often a good one, a bad one, and one that was a straight line extrapolation of today," O'Connell said. "The current combination of human judgment and computational power allows the rapid consideration of thousands, maybe

CHOOSE YOUR CRYSTAL BALL

We asked experts about their favorite tools for harnessing Big Data to yield predictions. Here's our short list of what's trending:

DATA CENTER at a SAP HANA location in St. Leon-Rot, Germany.

SAP HANA allows you to turn a hypothesis into a question, and then query a database with real-time results. Whereas an old-school database might allow one query a week, HANA can handle several per day because its data is stored in RAM.
hana.sap.com

GEOFEEDIA helps you take geo-tagged social media posts from Twitter, Facebook, Instagram, YouTube, Flickr, Picassa, and Viddy and plot them on a map. This allows social media content, which you can filter by keyword, to be monitored in real time around any location of interest.
geofeedia.com

HADOOP is an open-source effort designed to scale up from single servers to thousands of machines, each offering local computation and storage and the ability to generate results quickly. Through its InnoVision directorate, NGA is defining areas in Big Data analytics to pilot in a Hadoop sandbox. This would allow analysts to analyze data without first having to go to multiple repositories based on how it was collected.
hadoop.apache.org

GEO-Q and GEOWAVE are among a number of NGA's open-source projects available through its GitHub account. Geo-Q is a web infrastructure that helps crowdsource information to support disaster relief and other humanitarian assistance efforts. GeoWave is a set of software that adds multi-dimensional indexing capability to Apache Accumulo.
github.com/ngageoint

millions of scenarios for a more systematic look at the future."

As the Intelligence Community transitions from a focus on tactical to strategic intelligence, the ability to predict and anticipate events and outcomes will only become more essential. However, Mark Lowenthal, president of the Intelligence & Security Academy, warns there are potential pitfalls in placing all national security problems in the hands of anticipatory intelligence.

"When you start treating Big Data as a panacea for intelligence, you're in trouble," Lowenthal said. "That's what's been lost in this conversation."

Human analysts are still vital to collecting not only vast amounts of data, but the right data, and validating it before generating predictions.

DISCOVERING VALUE IN THE DATA

Despite inherent doubts about the power of Big Data and predictive analytics, their applications have become mainstream. This is great news for Ilkay Altintas, director for the Center of Excellence in Workflows for Data Science at the San Diego Supercomputer Center at the University of California, San Diego.

"We're creating a culture of measuring ourselves," Altintas said. "We have sensors everywhere."

Three years ago, Altintas didn't even know she was interested in her personal fitness data collected through devices such as Fitbit; Now she claims she can't live without it. The ability to analyze patterns allows us to make smarter decisions, she said.

Altintas' team has taken on a new project called WIFIRE, aimed at predicting where wildfires will spread. WIFIRE creates models based on video footage, satellite imagery, and real-time wind, temperature, and humidity data.

"What are the changes that happen before an event happens?" Altintas asked. "We can imagine these questions, but it's really hard to compute this."

WIFIRE allows the team to build a prototype and learn about a fire while it's blazing. Although they're based in San Diego—a very wired city—lack of data remains a challenge. Imagine, Altintas said, expanding the program with all the data that will be generated within the

next decade. She said the key is not just modeling the data, but finding value and connection in real time.

"None of it matters if you don't have an application or important problem you're trying to solve," she said. "You look at the application, ask the questions, look for technologies that can be applied, and see what kind of answers are there."

In some fields, prediction isn't a novel concept—we've known for some time how to model and predict the trajectory of missiles. Industries less experienced in predictive analytics are experiencing the most significant effects from harnessing Big Data, according to Dr. Dave Warner, neuroscientist and director of medical intelligence at MindTel. In his consulting work with Red Bull, Warner is developing new methods to study the narrow dynamics of elite performers, both in traditional and e-sports.

"Traditional biology didn't have a lot of math help when I was growing up," said Warner, whose data visualization program, Antz, helps users better understand and process complex data. "Being able to predict to some better degree who are going to be the better athletes or surgeons—predicting for human performance—has the potential to change the

way things (such as preemptive recruitment into specialized performance-based professions) are done."

In Northern Virginia, Borne consults with a firm that works with the Veterans Administration to identify patterns of behavior indicating suicidal tendencies.

"Of course there is body language," Borne said, "but maybe they write something in social media using keywords. Maybe they came home to find a cheating spouse. These are hidden variables you're not seeing, but these are all signals."

Trends such as crowdsourcing and the share-everything social media mentality help analysts better connect the dots, while simultaneously raising concerns about privacy and security. The "Internet of Things"—the growing interconnection of devices and appliances ranging from heart-monitoring implants to smart thermostats—will only intensify the challenges that accompany the data deluge. Because loosely coupled data could produce inaccurate predictions, confident analysis depends upon keeping humans in the loop.

"The art of GEOINT is uniquely human," said Spatial Networks CEO Anthony Quartararo. "I don't think

116TH MILITARY Intelligence Brigade soldiers perform daily mission support of the warfighter at Fort Gordon, Ga.

PARTICIPANTS at one of the Predictive Analytics Center workshops, hosted by the DHS Science and Technology Directorate's Homeland Security Advanced Research Projects Agency, discuss Big Data challenges and brainstorm potential solutions.

algorithms or artificial intelligence can ever really approach the unique capabilities of what a human brings to the equation."

It's tempting but perilous to rely on computers, Quartararo added.

Another risk of living in a *Minority Report*-esque world, in which people think they know the crimes others will commit in the future, are false positives.

"After 9/11, the Department of Defense, the Defense Advanced Research Projects Agency (DARPA), and the Department of Homeland Security (DHS) all asked, 'How can we make sure it doesn't happen again?'" Borne said. "When they looked at patterns, they saw roughly 20 young men from an Arab country who traveled together with one-way tickets on the same credit card, communicating regularly. So the next time you see all these characteristics, and you arrest them, you might just be arresting the Egyptian World Cup soccer team."

Jeff Jonas, an IBM fellow and chief scientist of context computing, said it's narrow-minded to think rarities are always important. Things happen all the time that have never before occurred; it's all the other factors that might add significance to an event.

"Just because you have a big pile of data doesn't mean there's gold in it," he said. "People get caught up with, 'Wow! Look at all the things that are rare.' If you inspect each one, there's usually nothing interesting. It's generally got to be rare-plus."

STUCK IN THE TRIPTIK ERA

When David Kilcullen, founder of strategy firm Caerus Associates and a former counterinsurgency analyst, was a child, his parents took road trips and used the Australian equivalent of AAA's now obsolete TripTik—a spiral-bound flipbook of maps showing a particular route. Today, road-trippers turn to Google or Apple for maps and turn-by-turn navigation. The problem, Kilcullen said, is the government is still stuck in the TripTik era.

"We're trying to bring the intelligence world into the 21st century," he said. "Policymakers are still asking for stuff that equates to the TripTik, because that's what they've always done."

An outdated U.S. national security system yields a culture that is reactive rather than anticipatory, which is hardly a winning strategy, according to O'Connell.

"In a world where things are moving so quickly, we have to jump out in front of problems, not wait for them to happen," he said. "When you respond to something in crisis, your options are typically narrower and costlier. This puts a real premium on anticipating what might come."

Possible components to modernizing the Intelligence Community and preparing the workforce for anticipatory analysis include training, learning from the commercial sector and other industries, and embracing team-based methods.

Bray addressed the importance of "change agents" in public service, such as those who are willing to develop an incubator space to promote creativity and challenge employees to draft proposals as though they are pitching venture capitalists.

"Public service is doing what the U.S. founders intended: checks and balances," Bray said. "But now, rapidly changing technology requires us to rethink how we might deliver value to the public for exponential times."

Carmen Medina, a specialist leader at Deloitte Consulting with three decades of experience with the Central Intelligence Agency (CIA), said it's important to present quantitative information in new ways, beyond prose—but noted this is a largely new approach for the Intelligence Community. Medina said because it once took a

team of analysts 30 days to perform tasks that can now be done in one-hundredth of the time, it's important to reallocate resources and determine which jobs are no longer necessary. Her prediction: a smaller and smarter Intelligence Community in the future.

One example of this shift is the only one-year-old Predictive Analytics Center at DHS's Homeland Security Advanced Research Projects Agency (HSARPA). The center hosts a monthly, hands-on boot camp for 60–100 employees from DHS and other agencies, and covers topics such as indexing methods, extraction, Big Data 101, and Big Data security. HSARPA Innovation Director Stephen Dennis said the purpose of the center is to develop a knowledge base and help users make smart choices with technology.

"Our goal is to be on the cutting edge of analytic technologies," Dennis said. He acknowledged the incongruity of placing "cutting-edge" and "government" in the same sentence, especially when the commercial innovation cycle is about six months while the government acquisition cycle is significantly longer. But HSARPA is piloting new data storage, visualization, computation and analytics, and security and privacy tools, and is looking decades into the future, he added.

For example, a technology that would allow U.S. Customs and Border Patrol agents to compute risk at exponentially faster speeds could allow them to make quicker decisions at ports of entry, where they are charged with stopping cargo that might pose a threat to the country while maintaining the flow of commerce. The center studies recent innovations at other agencies including DARPA and the Department of Energy—whose national labs have some of the world's fastest supercomputers—and considers whether they could be applied against national security needs.

"It's a lot of education," Dennis said. "People really want to have a dialogue about the art of the possible."

To help realize what's possible, the National Geospatial-Intelligence Agency (NGA) has begun a significant initiative to better structure and standardize its data sets. Bryan Goltry, the senior GEOINT officer in NGA's analytic capabilities portfolio, said the agency is in the earlier

stages as it looks to apply the type of predictive and anticipatory analytics to Big Data that industry and commercial GEOINT applications are leveraging.

"Despite making progress in the structuring and standardizing of data sets, we haven't quite realized the full extent of what Big Data processing can do for us," Goltry said. "We need to invest more into algorithms that do spatio-temporal processing of remote sensing data. This should, in turn, support linking to other relevant IC data and NGA data holdings."

Throughout this process, NGA will seek better and easier-to-use tools for interacting with data; systems and algorithms working across multiple security domains 24/7 to correlate the data, find the needles in the haystacks, and tie them together; and capabilities that empower users to answer broader questions and even determine the questions they're asking.

The Intelligence Community has just barely scratched the surface of anticipatory intelligence, Agee said,

and a number of challenges remain. While data standardization, accessibility, and policy challenges are evident, understanding the role of anticipatory intelligence in the modern intelligence cycle is perhaps the subtler but most significant obstacle.

Intelligence Community leaders should consider: how anticipatory intelligence might change the intelligence cycle; how to maximize the utility of anticipatory intelligence against nontraditional threats; and what the appropriate balance is between man and

machine—and between clear-cut predictions and more nuanced anticipations.

Agee said identifying best practices is paramount.

"Since anticipatory intelligence is in a neophyte stage of development, it is not yet codified in doctrine, and there's nobody really in charge," he said.

As the community moves forward, advanced analytics will be increasingly necessary to extract meaning from an ever-mounting volume of data. But without skilled human analysts, Agee said, those analytics will not be enough. ▦

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HOW ADOBE SYSTEMS FEDERAL HAS MADE ITS MARK ON DATA ANALYTICS, OPEN-SOURCE SOFTWARE, AND INSIDER THREAT DETECTION

For the past 20 years, few companies have done more to shape the way digital content is created than Adobe Systems. From Acrobat and the Postscript Document Format (PDF) to Photoshop and Illustrator—just a few of its many contributions—Adobe's software applications set a new standard and quickly became the go-to tools for creative professionals.

But Adobe is more than just a toolmaker. The company has expanded its ecosystem through a series of acquisitions to manage not only the output from its tools, but the way people interact with that output. The goal is straightforward, according to Craig Bowman, Adobe Systems vice president of defense and national security solutions: Get the information from who created it to who needs it in the most efficient way possible.

"It's an interesting shift in the company's ecosystem," Bowman said, "For the longest time, Adobe has been the company that makes the tools people use to be creative. Now we're not only doing that, we're managing in the cloud how [data] is stored, and then through analytics we're managing the way [data] is delivered on any device on the planet."

When Adobe Systems Federal was created in 2008, the decision was made to market very specific solutions for customers' needs rather than simply offer Adobe products. Each solution incorporates a host of Adobe products configured by Adobe engineers in a way that best meets the customers' unique needs, Bowman said.

ACQUIRED CAPABILITIES

Adobe has a long history of acquisitions, but the two most significant in recent years are Omniture in 2009 and Day

ADOBE ANALYTICS brings clarity to thousands of activities being monitored by sensors.

Software in 2010. The acquisition of Omniture, now called Adobe Analytics, catapulted Adobe into one of the top analytic companies in the world, according to Bowman. Omniture's web analytics, measurement, and optimization technologies enable sophisticated custom tailoring of digital content delivery for each user on any device.

The acquisition of Day Software, an enterprise content management software company, included two talented individuals who subsequently joined Adobe. Roy Fielding, inventor of the Representational State Transfer (ReST) protocol and co-founder of the Apache Software Foundation, was appointed Adobe's senior principal scientist. And David Nüescheler, former CTO of Day Software and creator of Apache Jackrabbit and Apache Sling, became Adobe's vice president of enterprise technology. With these additions, Adobe planted its flag in the open-source community.

THE OPEN DEVELOPMENT TRIFECTA

In this expanding ecosystem, the "open development trifecta" is Adobe's new doctrine: open source, open standards, open architecture.

Bowman, a developer and engineer himself, believes some open-source platforms, such as the Apache stack, which Adobe now uses, are actually more secure than government solutions.

Anyone—and therefore a larger number of users—can assess the code of open platforms. If hackers can find a loophole or vulnerability, so can the incubation team and others using the code. With government-developed software, on the other hand, a potential vulnerability may not be discovered until a hack occurs.

Though there are many companies offering solutions built on Apache or even open-source platforms similar to Apache, Adobe's edge is the two Apache pioneers leading its development team.

"We can do it better because we have the expertise from [Fielding's and Nüescheler's] years of development in the Apache Foundation and we know how to wire all these Apache projects up in a way that will be more secure," Bowman said.

DOWN TO THE BULLET

"In the public sector, the biggest area of growth has been around cybersecurity," Bowman said. Five years ago, he continued, Adobe set out to build the most secure platform the government had ever seen.

Adobe built a system for securing content from the moment it is created. Content is secured at the very highest level of attribute-based access control, tagged with the appropriate markings, and then, when a person requests it, the system checks that person's credentials to make sure he or she has authorization to look at the content.

"The difference between what we've built and something else is that we can protect the content down to the bullet level," Bowman explained. "We can literally remove a bullet from a piece of information based on who is asking for it."

Behind the scenes, all user actions across the system are monitored by Adobe Analytics for potential insider threats, checking log files for anomalies to detect if an individual is performing actions out of sync with his or her role, Bowman said. For example, if an employee is downloading or printing large numbers of files or accessing material he or she wouldn't typically have a need for.

"We have to start treating content as PII [personally identifiable information] from the moment it is created," he said. "The analytics, the tagging, the protection, all of that has been built [into Adobe's system], and it's currently in use at different government agencies."

The consensus from those agencies, according to Bowman, is that the system is "extremely powerful."

SPEED TO MEANING

"Success is no longer measured by how fast you deliver a map, it's how quickly did you deliver the meaning that the person requesting the map was looking for," Bowman said.

He used the example of a warfighter requesting a map from the field.

"If the map is not at the correct zoom factor and you have to pinch and zoom in, our analytics can determine that the map was delivered to you at the wrong zoom frequency," he said.
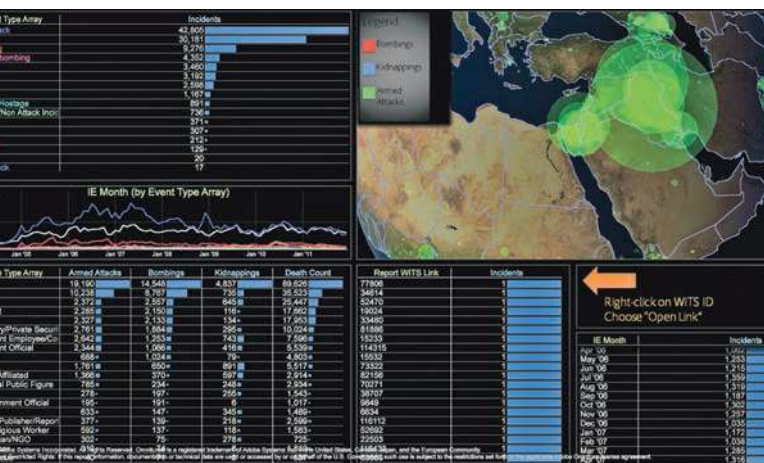
"[The next solider who requests the map] will get it at the correct zoom factor because we've monitored what you did on your mobile device."

Adobe's Mission Planning and Mission Mobile solutions provide a workflow that allows users to create, collaborate, protect, and disseminate critical information in a multi-domain environment to a warfighter in near-real time.

But Bowman said most of Adobe's customers don't care what the system is called, or what components are at work under the hood.

"What they want to know is can [Adobe] deliver faster and more efficiently than something else?"

Bowman certainly thinks so, as must Fielding and Nüescheler. For these open-source juggernauts to join forces with Adobe, the company must be doing some extraordinary work. ■ BY BRAD CAUSEY
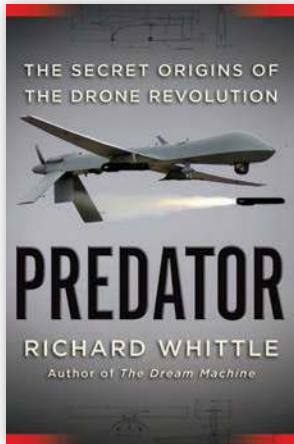
READING LIST

PREDATOR UAV: THE UNTOLD STORY

Predator: The Secret Origins of the Drone Revolution by Richard Whittle aims to tell the "untold story of the birth of the Predator" UAV, including how the weapon transformed modern warfare and launched a revolution in aviation.

Whittle, who spent 22 years covering the Pentagon for *The Dallas Morning News*, wrote "The Dream Machine: The Untold History of the Notorious V-22 Osprey" in his first few years out of the newsroom. He then began researching the origins of unmanned aviation and soon realized they lied with the Predator.

Whittle said he was surprised to learn the Predator's design didn't begin with the usual suspects in the military industrial complex, but with a series of innovators along the way. Most notable was Abraham Karem, an aeronautical engineer who immigrated to the United States from Israel in 1977 and began working on a new kind of endurance UAV in his Los Angeles garage. Karem failed at selling his UAV to the Pentagon, but his ideas were salvaged when purchased by General Atomics.

"It's a story of innovation," Whittle said. "I started out thinking it was just going to be a story about this extraordinary aircraft, but it's a story of invention, the politics of defense acquisitions, war, the Air Force, the CIA, and all those elements combined to create what is in fact a world-changing weapon."

In January 2000, the U.S. military owned 82 UAVs of three types. By 2010, the military had 8,000 UAVs of 14 types, and today it has more than 10,000 systems, according to Whittle.

He hopes this book, which he described as including a lot of drama, a touch of "geekery," and several never-told-before stories, will appeal to anyone interested in invention and intelligence, as well as help foster a more informed discussion about the use of militarized UAVs.

USGIF EVENTS CALENDAR

MARCH 10
GEOINTeraction Tuesday
Maggiano's, Tysons, Va.

MARCH 19
YPG Third Thursday
Northern Virginia

APRIL 21-23
NASIC Workshop
Dayton, Ohio

MAY 12
GEOINTeraction Tuesday
Maggiano's, Tysons, Va.

JUNE 22-25
GEOINT 2015 Symposium
Washington, D.C.

NOVEMBER 16-20
GEOINT Community Week
Northern Virginia

PEER INTEL

Michael Gazarik was named technology director of Ball Aerospace, effective March 2. He has an 11-year career with NASA and 25 years of experience in the design, development, and deployment of spaceflight systems.

Leidos selected **Michael E. Leiter** as executive vice president for business development and strategy. He previously worked in many leadership roles, most recently as a counselor to the CEO at Palantir Technologies. Prior to Palantir, he served as director of the National Counterterrorism Center.

Former Defense Intelligence Agency Director **Lt. Gen. Patrick M. Hughes** joined Hazelwood Street Consultants as a senior consultant, and is now available for principal and senior executive service level consultation to all clients.

Northrop Grumman selected **Faith Jennings** and **Vic Beck** to lead communications for the company's Aerospace Systems sector's unmanned systems and military aircraft divisions. Jennings has more than 20 years in the industry, most recently with Raytheon. Beck is a retired rear admiral, having served in the wars in Iraq and Afghanistan.

Brody Stout was appointed Boundless' chief operating officer and chief financial officer. He will be responsible for financial strategy, as well as overseeing the operational budget and managing the company's operations and finance teams. Additionally, **David Raissipour** became Boundless' senior vice president of product and engineering. With more than 25 years of experience, Raissipour will be responsible for the strategic direction and ongoing development of Boundless products.

In Memoriam

Mike Dean, Raytheon BBN Technologies principal scientist, passed away Nov. 19, 2014, after a 10-year battle with cancer. Dean was with BBN for more than 30 years, primarily working on the semantic web movement. Dean was an active volunteer with USGIF, having served as the first chair of the USGIF Technical Committee's Emerging Technologies Subcommittee. The board of the Semantic Web Science Association recently presented Dean with a special service award in recognition of his founding role in developing semantic web technology.
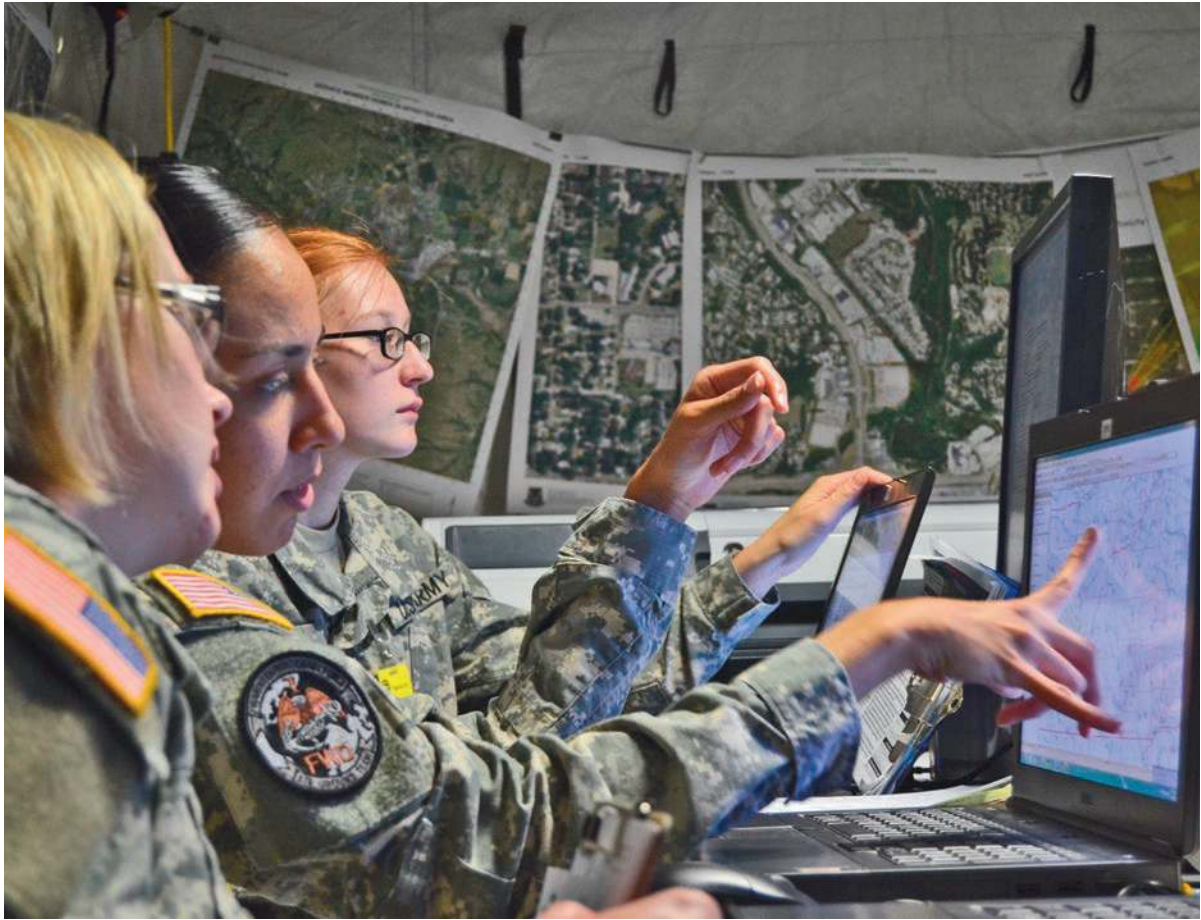
GEOINT In Demand

As global threats increase and technology advances, both industry and government face a growing need for trained geospatial imagery analysts. Whether it's gathering data to carry out operational planning for the Ebola relief efforts in West Africa or analyzing points of interest related to terrorist activities, these jobs are essential to national security. An ASDReports market forecast released in November predicts the GEOINT market will reach $9.7 billion in the next 10 years. However, a highly trained and skilled workforce is required for this market growth. USGIF supports a nationwide initiative to get more students in the pipeline for careers in GEOINT, and the Foundation's accreditation of colleges and universities moves the U.S. closer to this goal. The Foundation also supports a global Universal GEOINT Credentialing program.

In recent months, the U.S. Army has made several social media pushes encouraging followers to consider careers as geospatial engineers and imagery analysts. It's becoming increasingly clear that students entering the workforce equipped with GEOINT skills will find themselves in high demand. Not only is there a need for more geospatial analysts, but the call for women to partake in science, technology, engineering, and mathematics (STEM) careers continues to be important. In this image, U.S. Army National Guard Capt. Jennifer Staton, space operations officer, and Sgt. Cassandra Quinones and Pfc. Miranda Yost, geospatial engineers, use mapping software during a multi-state, large-scale natural disaster emergency response exercise. As senior intelligence leaders and academics suggest, a national emphasis on STEM and geospatial education, as well as a Community-wide focus on creating a more diverse workforce, are critical to achieving future mission success.

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