INFRASTRUCTURE & ENVIRONMENT

IMPROVING THE DAMAGE ASSESSMENT OF YOUR MILITARY INFRASTRUCTURE
Ensuring Mission Sustainment with Enhanced Data Collection, Analysis and Visualization

Outdated Methods of Infrastructure Damage Assessment

In a time of constrained budgets and expanding missions, Department of Defense (DoD) organizations operate with lean efficiency and little tolerance for breakdowns in physical infrastructure. When any piece of infrastructure at a military base or installation is damaged or fails to operate properly — for example, an electrical system goes down, a fuel storage tank or water pipe starts leaking, or training sites, roadways, or runways are damaged — that organization’s operational capabilities are weakened and its mission capabilities threatened. Consequently, the ability to rapidly assess and repair damaged infrastructure is critical to mission sustainment.

This is no easy task. DoD manages over 24.9 million acres of land worldwide, occupying 276,770 buildings comprising over 2.2 billion square feet. These locations also contain 178,113 structures (e.g., towers, storage tanks, piers, and wharfs), and another 107,092 linear structures (e.g., runways, roads, pavement, fences, and electrical distribution lines). Many of these infrastructure components and their myriad subcomponents are exposed to strong winds, rain, and other natural forces that can degrade capabilities until, suddenly and without warning, they are rendered inoperable; many are also located in areas subject to hurricanes, floods, earthquakes, tornadoes and other natural disasters that can cause widespread damage; and some are located in regions of the world vulnerable to destruction from enemy attacks. In such cases, the base commander’s goal is to quickly assess damage with sufficient insight to pinpoint the cause and extent of damage, and then implement a recovery plan that restores required functions while sustaining operations and mission capabilities.

Unfortunately, current methods for conducting damage assessments are labor-intensive and can be time-consuming, expensive, and potentially dangerous to those charged with making the assessments. Many military bases encompass more than a hundred thousand acres of land, including forests, water, and rugged terrain, with electrical systems, water pipes, housing, training facilities, and other infrastructure spread across the landscape. To identify damaged or malfunctioning infrastructure, commanders currently send out assessment teams to physically observe and evaluate each building, tower, road, pipeline, etc. This can be especially difficult when inspecting widespread damage following a large-scale disaster, such as a hurricane or earthquake. Travel to remote or damaged areas can be slow and dangerous, thus delaying repair and recovery.

Current methods can also create data issues that weaken assessments and undermine effective decision making. For example, errors can creep into the data through manual input or the subjective assessments of individual inspectors. Even more problematic, the assessment data is often collected and stored in disconnected systems. Siloed systems prevent the information sharing needed for advanced analytics and enterprise-wide analysis that, in turn, can support decision makers with timely, accurate, and integrated insights into the causes and extent of infrastructure damage.

Ultimately, the outdated methods for collecting and analyzing damage assessment data are not only costly and inefficient, but they also hinder the expeditious restoration of mission-critical infrastructure and operations. The challenge is finding a more cost-effective approach that can provide decision makers with the accurate data and objective insight they need to respond rapidly and restore operations after infrastructure is damaged or suddenly malfunctions.
We believe DoD leaders can gain the insight they need for objective, data-driven damage assessments by incorporating commercially available technologies and solutions into the decision-making processes and tools they use to inspect and analyze damaged infrastructure. Defense organizations are already familiar with these technologies, such as unmanned vehicles and sensors, which they are using to support other mission areas. The key is understanding how to apply the technologies to modernize damage assessment activities and extract greater insight from the collected data.

The main elements underlying this new perspective for improving infrastructure damage assessment and decision making include:

- **INNOVATIVE AUTONOMOUS DATA COLLECTION PLATFORMS.** DoD organizations can accelerate data collection by using unmanned aerial vehicles (UAVs), ground vehicles, submersibles, and other autonomous platforms equipped with sensors. In addition to gaining easier access to remote or hazardous locations, especially areas where widespread damage has occurred, these platforms can also fill gaps in current data collection methods. DoD could also repurpose existing platforms, such as satellites, to enhance data collection.

- **MULTISPECTRAL SENSORS.** Deploying video and photographic imaging, as well as infrared, topographical, and LIDAR sensors on fixed assets or autonomous platforms to collect real-time imaging and infrastructure data has proved very effective. Advances in storage and computing power have enhanced the ability of small, sensor-carrying platforms to collect and deliver valuable data.

- **POWERFUL CLOUD COMPUTING.** DoD organizations already collect large stores of data that can inform infrastructure assessment—for example, by providing a baseline of activity to measure or detect change. At the same time, they can also take advantage of public or open-source data sets, as well as enhance existing data with new sensor data from unmanned systems and other sources. The maturing of cloud computing now enables organizations to store, access, share, and manage massive amounts of data mined from these varied sources.

- **ADVANCED ANALYTICAL SOLUTIONS.** Modern analytic tools can apply sophisticated algorithms and models to parse through large amounts of data to detect anomalies and trends, and conduct multi-dimensional analysis of potential problems, solutions, and costs.

- **VISUALIZATION.** Modern decision-making tools can integrate and present complex analytic findings in dashboards and other displays, providing decision makers with a realistic picture of the infrastructure situation in a 3D/4D virtual or alternative visual reality (e.g., simulations, holograms, and multidimensional analysis). This enables them to clearly analyze and compare damaged infrastructure against a baseline of normal functions or activities across their entire infrastructure portfolio.

Dynamic Data Collection and Processing For Clear Visibility Into Damaged Infrastructure
Applied together, these advanced technologies offer many opportunities to accelerate the data collection process, enrich existing data, and create new efficiencies and solutions that go far beyond the 1950’s-style damage assessment methods currently in place. For example, UAVs and other data collection platforms, combined with next-generation analytics and data visualization, can anchor a more efficient, accurate and timely assessment approach – and at a substantially lower cost than physical inspection teams. Infrared UAV sensors can rapidly survey large and/or difficult to reach locations, efficiently pinpointing structurally unsound or impaired areas of concern. Equipped with LIDAR to establish a building’s 3-D structure and GPS to supply coordinates of a particular building, UAVs can utilize infrared capabilities for surveillance of larger groupings of buildings in a single flight. Thus, as opposed to inspecting buildings individually, airborne infrared sensors allow for an expedited analysis of potential structural issues among facilities throughout a damaged area.

The advantages of using unmanned vehicles to assess building damage also hold for inspections of other types of structures, such as towers, bridges, and fences. This allows the teams to conduct surveys more rapidly and, if needed, re-inspect damaged infrastructure more easily. The assessment processes are repeatable and the sensor data is reliable, measurable, and shareable, while the automated inspection reporting gives decision makers on-demand access to an objective, enterprise-wide view of damaged infrastructure. It should be noted that physical teams are still necessary — for example, to inspect infrastructure where sensor data has indicated a problem, such as steam pipe leak or excessive corrosion of electrical wires. But the overall reduction in the need for physical inspections will reduce costs while increasing worker safety, particularly when assessments involve rugged, difficult-to-reach locations or large expanses of badly damaged infrastructure following a major disaster. Ultimately, the time required to assess damage will be significantly decreased, while the quality of actionable information provided to decision makers will be significantly enhanced.

Capitalizing on these new technologies will require a new approach to assessing damaged infrastructure, analyzing the data, and presenting the results to decision makers. The goal isn’t simply to collect more data but, more importantly, to replace outdated practices with more powerful, cost-efficient methods, while also leveraging existing data sources. To extract maximum value from the collected data, the new approach will integrate the diverse data sets to facilitate rigorous analytics and present a comprehensive, enterprise-wide view of the extent of damage, including how the damaged infrastructure impacts operations across the entire the infrastructure portfolio. Of course, each military base or installation will have its own unique infrastructure and mission requirements, and so, ultimately, we must tailor the technologies to those requirements and needs.

As shown in Figure 1, our approach depends upon the consistent application of rapid data collection, analysis, and visualization. Each assessment will typically involve the following phases, although they may manifest differently depending on the need. But this represents the most effective approach to incorporate commercially available technologies and solutions into infrastructure damage assessment, analysis, and decision-making for defense and intelligence organizations.

The first step involves developing a diagnostic of existing data and client needs: What data does the organization already collect or have on hand that can inform damage assessment? What additional data will decision makers need to effectively assess damaged infrastructure and construct a path forward? Data collection and analysis represent a complex and challenging undertaking due to a number of factors, such as lack of relevant data, an abundance of data, the high cost to collect data, data anomalies, multiple data systems, and gaps that limit the ability to conduct integrated analysis.

With this insight, the next set of activities focus on filling gaps and accelerating data collection using innovative platforms and sensors, as well as open source and untapped data sources (e.g., weather), and techniques to enhance data, such as geotagging. In particular, advanced unmanned systems and sensors can provide assessment coverage that is deeper, wider, and more reliable, giving decision-makers tremendous visibility into

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**Integrating Rapid Data Collection, Analysis and Visualization for Better Decisions**

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their infrastructure portfolio. For example, sensors that have been strategically placed along a pipeline or electrical grid can provide instantaneous feedback to identify problems or, at least, narrow the scope of investigation.

We then establish the processes and controls for connecting accurate, timely data. Accurate data provides the foundation for high-end analytics and the development of alternatives. It is essential for identifying anomalies, tracking changes, and making process, facility, and equipment adjustments. Identifying the right data sets and knowing what to analyze requires staff with expertise and knowledge in facilities, public/private partnership process, power/energy, water/waste water, and the organization’s mission.

This expertise, when combined with strong communications skills, an ability to work across functional boundaries, and an understanding of the linkages and synergies of data helps organizations create the most effective damage assessment tools and processes.

The final set of activities focus on providing results by strengthening decision making through modeling, simulation and machine learning. Organizations can get a significant return from their expanded data collection by applying advanced decision-making tools and techniques, which allow for complex, dense sets of data to be analyzed faster and more cost effectively. These tools can analyze enormous sets of data to highlight the anomalies and trends that vary from the rest of the set. In addition, the tool's capacity for multi-dimensional analysis enables it to study more factors at one time, allowing the analyst to understand how each variable relates to the others.

This capability helps organizations pinpoint and resolve problems within a large infrastructure portfolio, with limited time and resources. Moreover, this activity creates an integrated alternatives analysis that generates clear recommendations and enhanced decision making to sustain operations while damaged infrastructure is efficiently repaired or replaced.
Booz Allen: Your Essential Partner in Improving Damage Assessment

Booz Allen has decades of experience exploring, analyzing, and addressing complex infrastructure challenges with U.S. government agencies. We have been at the forefront of groundbreaking efforts to improve infrastructure damage assessment and infrastructure management. We deliver leading-edge expertise across the asset management lifecycle and bring a strong understanding of critical infrastructure elements, including planning, capital project management, operation and maintenance, energy, space management, water and natural resources, security, and resilience.

DOMAIN EXPERIENCE. With over 1,000 subject matter experts on Infrastructure, Energy, and Environmental issues, we can assist in solving some of your most complex challenges. We understand that each service branch and each installation has unique infrastructure and mission requirements. Our tailored approach combines deep understanding of the DoD infrastructure portfolio and environment to ensure a comprehensive view of issues and solution development. Our experience integrating planning and execution activities adds accountability throughout the project lifecycle to ensure mission objectives, cost, budget, and key stakeholder requirements align throughout the process.

DATA SCIENCE AND ADVANCED ANALYTICS EXPERTISE. Seeing the need for a new approach to distill value from our clients’ data, we built a multidisciplinary team of computer scientists, mathematicians and domain experts to tackle the collection of problems and opportunities for leveraging data. Their collaborative effort immediately produced new insights and analysis paths, solidifying the validity of the approach. Since that time, our Data Science team has grown to more than 600 staff supporting dozens of clients across a variety of domains. This breadth of experience provides a unique perspective on the conceptual models, tradecraft, processes, and culture of Data Science.

STRATEGIC PARTNERSHIPS. We have examined and tested the critical technologies and solutions essential to the new approaches for infrastructure damage assessment; and we have formed partnerships with many of the leading providers of unmanned systems, sensors, and other technologies. We bring an objective eye to our evaluations of competing technologies, which allows us to select the best solutions for our clients.

Our experience, expertise and strategic partnerships are especially well-suited to helping agencies implement new approaches for assessing damaged infrastructure, including data collection, analysis, and visualization. Booz Allen is committed to providing proven tools and technology to accelerate diagnostic and data gathering efforts, establish meaningful data connections and improve decision-making capabilities for infrastructure damage assessment.

NOTES

2. These are referred to as UxS, since they can operate in all domains—air, ground, surface, and subsurface
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About Booz Allen

For more than 100 years, business, government, and military leaders have turned to Booz Allen Hamilton to solve their most complex problems. They trust us to bring together the right minds: those who devote themselves to the challenge at hand, who speak with relentless candor, and who act with courage and character. They expect original solutions where there are no roadmaps. They rely on us because they know that — together — we will find the answers and change the world. To learn more, visit BoozAllen.com.