UAS INSPECTIONS

ARE used a drone to inspect the Ohio River Bridge.

Photo Credit: ARE

ORDERING A COMBO

Bridges and drones go together perfectly when it comes to inspections

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Bridges and drones. Now that's a combination. But why? Are there direct benefits of applying UAS/drones in the inspection of railroad bridges? And if so, for what reasons? Answering these questions might seem obvious. However, there's quite a bit to consider, especially when you factor in safety procedures, risk assessments, airspace approvals, mission planning, travel logistics, defect recognition, situational awareness, obstacle avoidance, photo capture, data management, training proficiency, and much more.

The successful use of UAS technology in bridge inspections is complex. It requires expertise in piloting, a variety of equipment and sensors, experience with photography, knowledge of everchanging FAA regulations, and careful planning by the engineer and pilot to implement effective data-capture plans. Additionally, implementing a UAS program involves considerable investment in equipment, training, policy development, and understanding the risks associated with the technology.

We are frequently asked two questions: 1) Will utilizing drones displace the use of equipment such as "snooper trucks" or physical tactile inspections? 2) What are the advantages and different applications for utilizing drones on railroad bridge inspections? Both are great questions. The short answer to the first question is "no, the use of a drone will not remove the overall need for a snooper truck." At least not on more technical and detailed bridge inspections. However, the extent to which snooper trucks or equivalent equipment are required is reduced and focused on more exact inspection points with a better understanding of pre-existing conditions and the data-collection requirement. The same applies for climbing or repelling off bridge structures for tactile access. In terms of the second question, there are just too many critical measurements and risk factors to say that any one method alone (drone, snooper truck, tactile, etc.) is best. Utilizing one method (tool) or some combination of all three is dependent on the priority ranking, bridge type, environmental conditions, risk assessment, and data to be collected. The advantage of having drones and various sensors in your tool bag is the safety, variety, and efficiency with which data can be collected. UAS data collection can include high-resolution video, still images, thermal (surface delamination), photogrammetry (global geometry and terrain mapping) and LiDAR (geometric measures and terrain modeling).

Stepping into it

There are many advantages to utilizing drones for railroad bridge inspections that include:

1) UAS allow inspectors to view a structure in a way that encompasses the "global geometry." In this way, the inspector can view the structural integrity of small components of the bridge, while also being able to view those components in conjunction with the surrounding structure. This helps to clearly convey the bridge conditions to the bridge owner;

2) By providing a quick, detailed overview of an entire bridge, especially the difficult-to-access areas, inspectors can easily determine where additional hands-on inspection will be beneficial. This enables inspectors to focus their tactile inspection efforts and limit the need for climbing and other equipment, thereby mitigating risk and safety incidents;

3) When a condition that requires monitoring is located, the inspector can mark the spot when performing the tactile inspection. UAS with high-definition photography can then be used to perform ongoing monitoring;

4) Using UAS on large, complex bridges significantly improves overall productivity and allows the bridge to be viewed without fouling the track;

5) The flexibility to use a multitude of sensors to capture data and provide alternative perspectives. Consistent annual documentation can provide a useful history for assessing changed conditions over time or impacts from catastrophic events;

6) Data can be organized and tagged. Essentially fixed to a known location "in space" and time-stamped (i.e., geo-referenced). This ensures organization, avoidance of lost information or orientation and integrity of the data captured.

The following is a typical workflow (process) for a UAS application on a railroad bridge inspection that assumes the flight and ground crews have obtained the necessary FAA Part 107 Pilot Certificate and have a registered commercial drone.

Step 1: Initial plan review. Make sure the deliverable and work environment are clearly understood and that you've checked the FAA airspace or LAANC (Low Altitude Authorization & Notification Capability) for any restrictions requiring specific waiver requirements or use and whether or not on-site waivers can be obtained.

Step 2: Scoping. Establishing safety protocols and procedures. This cannot be stressed enough. Every application and flight "has a different twist to it" and ensuring that you are always operating within safety limits is mission critical. And performing risk assessment based on site conditions that could result in:

A) Injury to personnel or bystanders due to UAS contact;

B) Damage to UAS equipment due to loss of control or pilot error;

C) Damage to manned aircraft and UAS due to a collision;

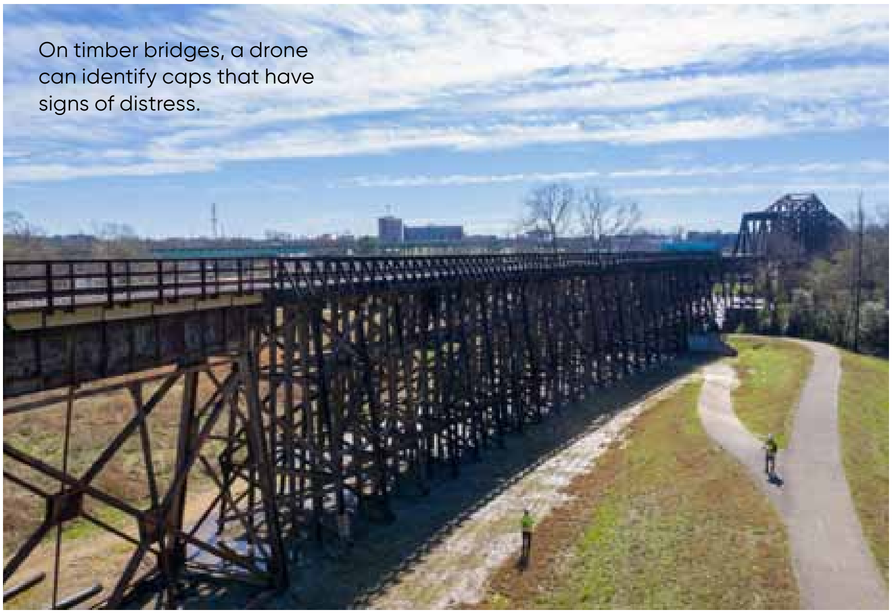
D) Injury to personnel due to slips, trips, and falls;

E) Damage to a train;

F) Injury to personnel due to locomotive or vehicle on the track.

Make sure you have adequate insurance coverage. The closer you operate to the bridge and encounter GPS shadow (having to fly without a good aircraft positioning signal), the higher the risk of an incident. You must know when to "bring the aircraft home" with plenty of fuel (electrical power) as well as avoiding surrounding obstacles such as wires, trees, birds, the bridge, etc.

Step 3: Flight operations. Determining which aircraft is the right choice for your application while maintaining an acceptable risk tolerance. This requires a thorough understanding of the bridge configuration and a detailed capture plan. In many cases tall or otherwise inaccessible timber bridges can use the DJI Mavic or equivalent (depending on your choice for the U.S. or foreign made). Larger steel bridges will require aircraft that can carry higher-resolution cameras with the ability to swap out the lens for greater optical zoom ranges, allowing you to fly further from the structure or tighten up the frame to see exactly what you desire without losing optical resolution. Another important feature is the ability to carry a top-mounted camera for underneath inspections, or even two cameras at once (for instance, a high-resolution zoom and thermal). And check aircraft (DJI or equivalent) "zoning" for consistency with FAA airspace, and if inconsistent, check for



On timber bridges, a drone can identify caps that have signs of distress.

Photo Credit: ARE

any required updates (constantly changing within DJI software).

Step 4: Mission plan. Compile scope of work and procedures to perform inspection safely and efficiently. We rely heavily on our Standard Operating Procedures for UAS Operations, UAS Safety Manual, and experience from operations and training exercises. The same goes for developing operational procedures that support consistency in how teams are dispatched, aircraft are operated and maintained, lessons learned documented and communicated, etc. Knowing the right software to use for mission planning and flight recording is a must, and once you decide, standardize as much as possible.

Step 5: Post processing. It is critical in post processing that the data collected (imagery, etc.) during flight operations is captured at the correct resolution, orientation, file type, location, etc. Making sure that the deliverable expectations are a part of the upfront briefing (before the mission is flown) will help the post processing team achieve the best results. There's nothing like organizing a mission to find that the data is not useable. Tagging pictures and annotating if possible is another key step.

Step 6: Report generation. Understanding what data sets are important to include in the final report and the information you're trying to convey is important for the post-processing step. It helps ensure that the data can be used and incorporated into whatever format (paper, digital, etc.) the final report is delivered in. This is an area that can be developed into a standard workflow once the proficiency of your data-collection process improves.

Step 7: Data delivery. Decide what deliverables are best for each type of bridge inspected and how those deliverables are to be captured, organized, edited (post-processed), and managed. Data management is among the greatest challenges when capturing hundreds, even thousands, of high-resolution images, video or point clouds (GIS data). Make sure every flight and project includes a debrief. This is one of the most important steps in the operations and safety procedures for preventing future incidents and keeping everyone safe, equipment included.

Timber and steel

Timber bridges, in all cases, are going to require sounding or other means to determine the "soundness" of the timber member (internal hollowness or rot, while also determining the extent of exterior rot). In most timber bridge cases, "free climbing" the bents (as bridge inspectors are allowed per FRA ruling) allows for the entire structure to be inspected and assessed in detail. As timber bents start reaching two or more tiers, free climbing can become problematic (greater than a single layer of lateral "sway" bracing, typically greater than 14 ft 6 in. high for the AREMA-recommended max height for a timber trestle of 18 ft height from ground line to rail).

This is where the use of a drone comes into play. A drone makes for quick and safe photo and/or video documentation of the visual status of a cap and can identify caps that have visual signs of crushing, pile punching, and splitting, providing the inspector valuable information.

The other notable point for drones on timber bridges and others is to get a view of the substructure and superstructure over high/swift water where wading or the use of a boat simply isn't possible. This allows the inspector to make better-informed decisions on the timing of follow-up inspections.

The most notable steel bridge case to date for ARE is the augmentation of UAS into our inspection of the Ohio River Bridge, a nearly 4,000-ft bridge with a 20-span deck-plate girder (DPG). This bridge includes a trestle approach on the Ohio side of the river, which leads into a five-span thru-truss river crossing, followed by a 37-span DPG trestle approach on the West Virginia side of the river.

ARE utilized UAS to speed up the inspection process to view and document high-elevation girder bearings as well as tower bearings built up on high elevation. The UAS also aided in inspecting inaccessible stone pedestals for both approach DPG trestles. The higher-level UAS equipment really shines with the five-span thru-truss river crossing.

The first time ARE inspected this bridge, we used a combination of snooper truck and climbing to accomplish this task. Accessing the bridge floor system of these spans required extremely slow-moving snooper trucks that needed to be carefully articulated through the vertical and diagonal truss members in order to provide access for an inspector under the bridge. Alternatively, UAS flights provided high-resolution photos of all areas of the floor system, while keeping personnel safely on the ground. There was a much higher rate of data capture, without fouling track and restricting train traffic. The findings were then followed up with climbing or snooper trucks as needed, in order to address areas identified by the data captured by the UAS.

The application for utilizing UAS with railroad bridge inspections is tremendous. The benefits include safety improvements, productivity increases, and cost reduction, and the variety of data types that can be collected are extensive. Considering the different tools that are available, the UAS provides a unique vantage point in how one approaches the inspection process. Fly safe. RT&S