

Technology innovation in firefighting hotwashes

Effective firefighting debriefs – or hotwashes – share techniques, highlight best practices and discuss challenges. CRJ Key Network Partner, **Pix4D**, explores how photogrammetry can improve and enhance the debriefing process

Firefighting has changed over time and modern developments have transformed an age-old art. Digital and imaging technologies now play key roles. Thermal camera technology was a natural inclusion for the firefighting industry; being able to see the temperature of a fire can help firefighters analyse how it is burning and where it is the most intense. However, this has not been the only technological advancement using image capture – several fire departments now incorporate drones and photogrammetry into their workflow. Photogrammetry – the art of measuring from images – is a refined technique. Stitching together aerial images captured by drones provides an insight into the bigger picture. A ground-level view is useful, but it cannot tell you about how a roof is burning or even if it is caved in. If a fire is still burning or firefighters are assessing the damage afterwards, being able to see and model the bigger picture are valuable assets. In Indiana in the USA, the Richmond Fire Department soon realised the value of this and now uses photogrammetry outputs from Pix4D for debriefings, enforcing city zoning laws and fire investigations.

The drone team can set up on site quickly and effectively

Richmond FD

The 80 firefighter-strong department used a grant from a local bank to kickstart its drone programme. With five stations serving a city of 40,000 citizens, three members of the department are part of the drone team, which uses photogrammetry to model

sites after a fire event for post-response hotwashes.

Firefighter Jamey Miller leads the drone unit. Founded a year ago, the unit's current method is to fly a scene within 24 hours of a fire. The team aims to map the location after it is sure that the fire is truly over, but also when it has the best lighting conditions to capture imagery for processing – diffuse light or a cloudy day with no shadows provide the perfect conditions. The imagery is processed with a desktop computer that can handle Pix4Dmapper and other resource-intensive software.

When the Richmond FD responds to a call-out, the team uses several elements of hardware and software. In one particular incident, the team flew a DJI Phantom 4 Pro to capture external images of the structure and used an iPad Pro 2020 to run Pix4Dcatch. The drone images were processed in Pix4Dmapper – powerful desktop photogrammetry software – while the iPad images were processed in the cloud-based platform, Pix4Dcloud. The drone images were high-quality at resolutions of 20 megapixels, with 1,142 images taken in total. The whole process is very efficient: Miller and his team were on site for just 90 minutes, with a processing time of five hours.

Typically, Miller's unit flies the drone in double grid missions, using its 20-megapixel camera to capture imagery of the site and process the data in Pix4Dmapper. In the last few months, following the release of Pix4Dcatch – a mobile app that allows individuals to walk around a site and capture imagery with a mobile device – Miller and his team have explored implementing this application for capturing the interior of incident scenes. The app automatically extracts the correct number of images required to reconstruct scenes and geotags the photos to ensure that the models show the real-world location.

The team learnt that having proper lighting is also essential for capturing interior scenes post-fire with Pix4Dcatch, because the Sun cannot be relied upon to light up the interior of a burnt structure. The team therefore set up powerful LED lights that supply ample light, minimise any shadows inside and allow their mobile devices' cameras to capture soot-covered walls clearly. The data is typically collected the day after a call-out, so that as well as capitalising on daylight hours, the drone response team can take its time to gather all of the data needed for an accurate 3D model.

When working with external bodies such as the police, Miller uses Pix4Dcloud to share data and results. This is vital when using drones for vehicle crash investigations,



where there is a priority for fast responses for the investigation and to avoid traffic disruption. Uploading outputs processed in Pix4Dmapper to Pix4Dcloud only takes a few minutes. Using Pix4D software has dramatically changed how Miller's team completes its hotwashes and has allowed the creation of a valuable, shareable resource for use within the Richmond Fire Department, and externally with other agencies.

The team has discovered the optimum techniques for using Pix4Dmapper to get the best out of the software. Miller says: "Understanding how processing options will affect the outcome has been mostly trial and error experience. If you truly want to take advantage of Pix4Dmapper, you must be willing to learn the finer details." The unit's experience has also added to the accuracy of its models, as improving image collection techniques positively affects the whole project.

Debriefs, or hotwashes, are a crucial element of firefighting. Personnel on duty will report to their colleagues what happened in a response and how their team reacted. This allows firefighters to share techniques, discuss challenges and educate each other. In the past, this was only possible with drawings and verbal accounts.

A realistic 3D model in the form of a point cloud for the firefighters to use as a descriptive tool is a powerful innovation. Firefighters can provide an overview of events by showing exactly where each of their teammates moved and by narrating among their colleagues. Given the department has three shifts – A, B, and C – even if a firefighter was not at an event, the digital twin of the post-fire site enables them to imagine being there

more effectively than a simple verbal description. With better insights and discussion of the emergency response, they can make improvements for future responses.

In addition, these models are valuable to the city authorities. Richmond authorities enforce the city planning code, which involves demolishing buildings that are dilapidated and cannot be repaired. Abandoned buildings can pose a risk to the public, or be targets for arsonists, so demolishing them is a preventative measure for public safety.

Being able to create accurate 3D maps of a site very soon after an incident is invaluable. Where Google Maps or similar programmes can be several years out of date, Pix4Dmapper can be used to obtain a full, immersive impression of a location and show the damage that occurred in a fire. It also gives firefighters the chance to show colleagues where they applied particular techniques in a building.

Deputy Chief of Fire Prevention, Douglas Gardner says: "Being able to utilise the 3D model from the drone has assisted in multiple fire and life safety inspections and plans. Oftentimes we are unable to get the overall picture due to limited access to the property until we see the 3D model. I see the use of this programme growing due to the benefits we have gained from this technology."

The variety of uses of photogrammetry by Miller's unit show the multi-outcome advantage of using Pix4D software. No longer reliant on hand-drawn diagrams and outdated satellite maps, the Richmond FD creates its own replicas of buildings, giving the team an unparalleled level of detail and insight into its own work.

A burnt out building was 3D modelled afterwards for fire investigation and hotwash debriefs
Richmond FD

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