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## Rising to the Occasion: UAS for emergency and disaster relief

UAS are rapidly becoming an important tool for disaster response teams and emergency service units, but are they being used to their greatest potential?

By Patrick C. Miller | January 11, 2015

On March 11, 2011, following a magnitude 9 earthquake off the coast of Japan, a tsunami struck the Fukushima Daiichi nuclear power plant operated by Tokyo Electric Power Co., triggering a nuclear meltdown that caused mass evacuations from the surrounding area.

As horrific as the images from Japan were, it was the radiation leaking from the nuclear power plant that threatened to make the scope of the disaster even worse. But these events also provided an opportunity for unmanned aerial systems (UAS) to prove their worth while accomplishing what people couldn't in conditions that forced humans to risk their lives.

Robin Murphy, Ph.D., director of the Texas A&M Center for Robot-Assisted Search and Rescue (CRASAR) and founder of Roboticists Without Borders, was part of a team that traveled to Japan to help bring the situation under control. She worked out of Toshiba's headquarters in Tokyo, about 150 miles southwest of Fukushima.

Although satellites and manned aircraft showed the damaged plant from above, they couldn't see into the areas nuclear engineers needed to view. It was impossible for anyone to reach some of the areas where radiation measurements were most needed.

That job was delegated to four Honeywell T-Hawk micro air vehicles (MAV) remotely piloted by a specially trained three-person team. However, their experience was in tracking potential military targets in Afghanistan and Iraq, not flying in close proximity in or near heavily damaged buildings. That's where Murphy's expertise came in.

The two organizations Murphy leads first went into action using robots to explore the wreckage below the collapsed twin towers of the World Trade Center in New York in the aftermath of Sept. 11, 2001, terrorist attacks. It was after Hurricane Katrina in August 2005 that CRASAR used UAS to survey damage for the first time.

"Not only did we do the initial response, we were first up with small fixed-wing and rotocraft UAVs," Murphy says. "A couple months later we came back and had eight days of intensive flying at multistory commercial buildings in Biloxi along the Gulf Coast.

"Every night, we would pipe the data back to FEMA, to several of the top civil engineering schools and a top engineering consulting firm to let them see it," she explains. "When you have big damage, it means you need civil engineers and construction specialists to look at it."

The experience proved valuable six years later as events at the Fukushima nuclear power plant threatened to make a bad situation even worse. The CRASAR team knew how to operate UAS at low altitudes in urban canyons as opposed to the higher altitudes and open spaces where the military typically flew its drone missions. They understood the aerodynamics of operating in close proximity to damaged structures. And they knew how to get into and out of tight spots.

"Those are the sorts of things we'd been working on when we got called into Fukushima," Murphy notes.

Honeywell's T-Hawks enabled nuclear engineers to be in the loop and direct where they needed the UAVs positioned, such as in a plume to measure radiation emissions or to determine what was in escaping steam. Murphy characterizes the Fukushima UAS mission as extremely successful. Rather than making guesses or estimates, having the drones record measurements from various altitudes helped gather highly accurate 3D telemetry quickly.

"Certainly there are ways to do estimates, but, boy, it's nice when you have so many things going wrong to have the most accurate data possible and have it so much quicker than if you had to suit up a person and do it every day for a couple months," she says.

CRASAR continues to assist in disasters where it's invited and apply lessons learned to advance the use of UAS in disaster response. Its drones mapped the area of the March 2014 mudslide near Oso, Washington, that claimed the lives of 43 people. Closer to home, in May 2015, CRASAR assisted the Texas A&M Lone Star UAS Test Site in the search for survivors of a 300-year flood at Wimberly, Texas, where a dozen people died.

Besides keeping up with the latest technical innovations in robotics, Murphy says there's still much to learn about using UAS for disaster response, such as planning and coordinating with all entities involved. She says collecting data, analyzing it and quickly getting it to decision makers is crucial to exploiting UAS capabilities.

"We've been saying since Katrina that it's not about the UAVs, but once the platforms get good enough, it's really about the data," she explains.

### Hurricane lessons

Another company that learned an important lesson from Hurricane Katrina is Woolpert Inc., an engineering consulting firm with nearly 50 years of experience in conducting aerial surveys with manned aircraft. Jeff Lovin, senior vice president for Woolpert's



Former Canadian Air Force drone pilot James Power now flies an Indro RoboticS UAS for Renfrew County Paramedic Services in Ontario, Canada.  
PHOTO: RENFREW COUNTY PARAMEDIC SERVICES

division of government solutions, says that shortly after the hurricane subsided, the U.S. Army Corps of Engineers wanted the company to survey the damage along Mississippi's Gulf Coast.

"It took us several days to mobilize one of our large aircraft," Lovin recalls. "The airspace was shut down at the altitudes we wanted to fly. It was also being used for evacuations and to bring in supplies. Plus, the local airport infrastructure was devastated."

It was nearly a week before Woolpert could fly the survey mission. However, the company had surveyors on the ground immediately after the storm to collect GIS field data on critical infrastructure of interest to the Corps to determine whether it survived the hurricane.

"The same boots on the ground could have launched a UAS much earlier than we were able to get one of our larger aircraft down to there," he says. "It would have been a small UAS at a lower altitude that wouldn't have affected any of the other air traffic. It could have collected a lot more data much more quickly than we were able to on the ground."

As a result, Woolpert conducted a proof-of-concept project with the Corps of Engineers last year, using an Altavian fixed-wing UAS to conduct surveys of Ship Island off the coast of Mississippi and Duck, an island town on the Outer Banks of North Carolina. These two areas are frequently ravaged by hurricanes, Lovin says.

"Inevitably, there will be other storms that hit those areas," he explains. "The Corps definitely sees UAS as a valuable tool to collect a lot of data very quickly."

Woolpert has already begun training its ground survey teams to use UAS. Unlike Hurricane Katrina, Lovin says they will be prepared to deploy the unmanned aircraft and begin collecting highly accurate 3D LIDAR data soon after a storm subsides. And because of Woolpert's decades of aviation experience, they know how to coordinate their flights with local authorities.

#### First response realities

On the local level, first responders in emergency service units are discovering that UAS are an important tool for jobs ranging from searching for lost hikers in the woods to creating greater situational awareness at crime scenes, accidents, fires and public events. But they're also finding that obtaining UAS, learning how to use them and operating them within government regulations is a challenge.

Lt. Matthew Tiedemann, coordinator of the Bergen County (New Jersey) Office of Emergency Management says the agency has four UAVs and admits that progressing to the point where they could be used in daily operations was difficult.

"You would think it would be harder for someone to fly it who buys one off the Internet than it would be for a government agency," he says. "There's a lot of hoops to jump through and a lot of red tape to go through, but we want to do it right by developing a program with proper policies and procedures."

BCOEM formed a partnership with EagleEye Systems, a software and UAV technology company based in Brussels, Belgium, that also has an office in New York. Tiedemann says that not only has EagleEye helped his office set up a training program, but it also developed and customized a second-generation UAS to their fit their specifications.

"They brought their engineer with them and tweaked it right on site," he says.

According to Geoffrey Mormal, EagleEye chief technology officer, a second-generation UAV has autonomous capabilities that greatly exceed those of current small UAS, which use a simple autopilot. The system designed for BCOEM has multiple processors and an operating system that enable it to quickly process information gathered by its sensors for great efficiency.

This capability was demonstrated when Bergen County firefighters battled a blaze at an electrical substation. The EagleEye UAV was programmed to fly the four corners of the fire area. It quickly revealed that the main water stream was missing the most intense area of the fire.

"The firefighters were able to adjust the stream and get it on the fire," Tiedemann says. "They knocked it down faster than if they hadn't had that aerial footage."

Two years ago, at a mall in Hackensack, New Jersey, a man opened fire on shoppers. Fortunately, he didn't hit anyone before taking his own life. Because of the incident, Tiedemann says BCOEM conducted an active shooter exercise in the mall using its UAS in coordination with a SWAT team.

"It was amazing to use for looking around corners and checking out areas without having to send a SWAT team into harm's way," he notes.

In Canada, the Renfrew County Paramedic Services in Ontario is already incorporating UAS into its daily operations. Chief paramedic Michael Nolan says the population of the 7,000-square-mile county doubles to 200,000 in the summer when tourists, hikers, campers and canoeists arrive for activities and events.

"One of the challenges we have as a paramedic service is being able to respond in a timely manner and also be able to access people in remote locations, identify their location for search and rescue and be able to deliver goods—such as a defibrillator—to people who are in remote access locations," he says.

Renfrew County's use of UAS began when Nolan learned that one of his paramedics—James Power—was an ex-drone pilot for the Canadian Air Force. Nolan purchased a DJI Phantom 2 and Power began demonstrating its capabilities for others in emergency services who quickly realized its potential.

"It got early buy-in for people to appreciate a more spatial view of a complex situation in a training exercise," he explains. "It allows people to change their resource allocation and use it as a training tool for the debriefing of staff who were involved at a scene. It's a very different view being 200 feet above rather than staring at the helmet of the guy in front of you."

Those efforts led to a relationship with Indro Robotics in Salt Spring Island, British Columbia, a commercial UAS manufacturer with aviation experience. The company provided RCPS with a customized quadcopter and assisted the agency in working with Transport Canada to obtain a special flight operating certificate.

In addition to helping search for lost hikers and working large community events, Nolan says the UAS can be used to rescue someone who's fallen through ice, assist firefighters and investigate traffic accidents and crime scenes.

The UAS proved invaluable to the county's first responders on Sept. 22. A triple homicide near Wilno, Ontario, required them to

enter a crime scene when the shooter's location was unknown.

"We were able to go in and look in the windows, look under the building, look in the garage, as well as provide an over-watch service for the police officers as they gained entry to the property," Nolan relates. "We were able to identify the position and condition of the victim by using the UAV. It really gave the police a much greater appreciation for what they were going into to the extent that you could say it was probably the most meaningful help and safety tool that you can use for first responders."

#### Regulation changes ahead?

The use of UAS for emergency services is so vital that Nolan argues that legislators and regulators should treat it differently.

"Emergency service use should either have its own exemption or its own set of regulations that recognize the risk/benefit," he says. "Emergency service use changes substantially from someone using a UAV in the film industry or in real estate or for tourism. The existing regulatory framework doesn't take into account that if we do not have the ability to use a UAV to its fullest extent, that in itself can increase harm and risk to the subject by not allowing us to put our best foot forward as first responders."

"We need to help regulators by creating an acknowledgement that this isn't a one-size-fits-all utilization, that it comes with different risks and rewards for appropriate use," he concludes.

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