Using Drones to Detect Damage to Bridges Workshop

Summary Report

December 13, 2018 | 9:00 AM- 12:00 PM
Lakewood, WA

Workshop Summary
The Pacific Northwest Economic Region and its Center for Regional Disaster Resilience in partnership with Northeastern University’s Global Resilience Institute (GRI) were awarded a 2017 National Infrastructure Protection Plan (NIPP) Security and Resilience Challenge grant for critical infrastructure. This workshop will present the results of the technical research team (GRI) at utilizing self-directed drone technology (algorithms) and LIDAR to inspect damaged bridges in a post-disaster scenario.

Welcome and Introductions
Opening Remarks

Eric Holdeman, Director for the Center for Regional Disaster Resilience, opened the workshop by welcoming attendees and facilitated introductions of all participants. He then gave an overview of the workshop and its intended purpose to present the final technical report from Northeastern University’s work on the National Infrastructure Protection Plan (NIPP) Challenge Project focused on using Unmanned Aerial Systems for damage assessments. Mr. Holdeman explained that the workshop would be more technical in nature and was geared toward those involved in inspecting critical infrastructures in the event of a disaster, specifically bridge inspectors.

Mr. Holdeman gave a background on the NIPP project stated above and the Center for Regional Disaster Resilience’s (CRDR) road to receiving the grant as well as the steps taken to fulfill the requirements of the project. Mr. Holdeman introduced the partnership with Northeastern University’s Global Resilience Institute and their role in developing the technical side of the project while CRDR established a drone users’ group to determine who is using drones and how they are being used, as well as holding several workshops and a webinar.

Update on Drone Regulations and Usage in the Northwest

Tom Hagen, President of Association for Unmanned Vehicle Systems International Cascade Chapter, was invited to the stage next to give an update on drone regulations and usage in the Northwest. Mr. Hagen went through the recent FAA Reauthorization Act of 2018 which is a five-year reauthorization bill and explained the provisions that relate to drones and their usage. He highlighted the repeal of Section
336 of the act which was a special provision for recreational and hobby users of unmanned aerial systems (UAS)—or drones as they are more commonly referred to—to ensure that hobbyists were not burdened by the regulations that applied to more formalized and commercial UAS use. This repeal was protested, but ultimately, Mr. Hagen believes that it will be beneficial to the industry. Mr. Hagen went on to explain the updates or changes from previous reauthorizations and what that means for drone users, both recreational and commercial.

Mr. Hagen then went on to describe the various uses for drones, including the areas and industries in which they could be utilized most effectively. He mentioned four categories specifically and explained how drones could be used to aid and improve each area.

- He began with infrastructure inspections including oil and gas, utilities, construction, and insurance. Using drones for infrastructure inspections can reduce the need to put people in unsafe or unknown situations and make it easier and safer to assess damage.
- Secondly, Mr. Hagen talked about the use of drones for precision agriculture which he broke down into visual, multispectral, and remote sensing. Drones can be used in agriculture to give farmers a better, overall view of their land and its needs which can save money, water, and other resources.
- Thirdly, drones can be used in resource management to allow an overview of resources including inspecting land for invasive species and wildlife, monitoring wildfires, and observing other issues that cannot easily be detected or accessed from the ground.
- Lastly, Mr. Hagen brought up the benefits of drones for package delivery and urban mobility. Drones are already being used in third world countries to deliver aid relief and other similar operations. Mr. Hagen believes these services will likely begin to be implemented in the U.S. in the future. However, rules and regulations governing air space will needed to be changed to allow for these new services. Additionally, he mentioned the eventual use of drones as a sort of airborne taxi service to help reduce traffic congestion.

Mr. Hagen concluded by providing a list of UAS users that operate in the Pacific Northwest.

**Flight Operations**

Next to the stage was **David Tyler**, Manager of IT/ Telecommunications for Puget Sound Energy (PSE), who spoke on the development and implementation of Puget Sound Energy’s Aerial Operations Program. This program, while still in test mode, introduced PSE to the concept of using aerial systems for damage
assessment and inspections. PSE’s program made use of several different aerial systems including drones, helicopters, and airplanes. LIDAR was also employed. The intention of the aerial operations program was to serve as an aid to ground crews by allowing them a clearer and more complete view of operations, damage to these operations, and potential dangers or problems that might occur.

In the course of his presentation, Mr. Tyler revealed that employing drones in surveying actually created more work than anticipated for the program employees rather than reducing the workload as intended. This, in part, led PSE to postpone the use of drones as part of their program. A secondary factor was the effectiveness of drones in inclement weather. A drone can be less effective for damage assessment in the presence of wind, precipitation, and cold temperatures. Due to these factors, PSE determined that drones could not fulfill their needs at the time and would instead make more extensive use of helicopter and airplane footage.

After a brief question and answer period, attendees were dismissed for a short break.

Report on Technical Tools for Post-Disaster Damage Assessment

After the break, Dr. Taskin Padir, Associate Professor of Electrical and Computer Engineering at Northeastern University, began his presentation which covered technical elements of the NIPP Security and Resilience Challenge project. Dr. Padir started with a description of the project and the role his engineering team played in the scope of the project. The Resilience Challenge project was inspired by the needs that arise following a disaster which Dr. Padir explained was a good way to bring his team together on a new topic they haven’t worked on in the past.

Following the Fukushima nuclear disaster in Japan, Dr. Padir worked with DARPA on the DARPA Robotics Challenge which was conducted in the aftermath of the disaster. Dr. Padir pondered how much better would it have been if a drone could have been sent to assess the damage to the nuclear reactors rather than humans. This and other disasters like it act as motivation for post-disaster research to reduce the danger of assessing critical infrastructure post-disaster. While drones are beginning to be used in disaster scenarios, limitations still exist for drones. The particular goal of the NEU team’s research was to try to discover a way to reduce these limitations and make drones more effective and practical for use in post-damage assessment.

The main problem with operating a drone, according to Dr. Padir, is the human component. Humans are limited by their operational skill. The NEU team's solution was to develop a robotic system to operate the drone that would reduce or eliminate the human errors that could occur. The university built a drone cage for the project to aid in research and testing with a goal to work toward fully autonomous control of the drone. From here, Dr. Padir proceeded to walk the workshop attendees through the team’s research,
process, and testing. He presented photos and videos to demonstrate and illustrate the various elements of the team's work.

Dr. Padir closed his presentation by answering questions from the audience. When asked by a participant about the level of granularity the sensors could track cracks on concrete, Dr. Padir stated that right now the sensors are looking at centimeters and cannot detect millimeters of damage yet. On the topic of sensors, while the drones used for this project only utilized one sensor, a participant asked whether multiple sensors or drones could be employed to survey the same infrastructure or area to which Dr. Padir replied that could definitely happen. Another participant wanted to know how much of these mapping systems and algorithms are made available through open source platforms and why it was necessary for Dr. Padir’s team to develop their own. The participant used the example of a Roomba vacuum which employs sensors to detect its surroundings and asked what the difference was. Dr. Padir acknowledged that the underlying technology is similar; however, the difference has to do with the space in which each system operates—2D vs. 3D. Dr. Padir’s team was concerned with 3D sensing which is not being as widely used. When asked when this research could be implemented in a real-world scenario, Dr. Padir stated that the technology is still being developed and cannot be implemented on a commercial level as of yet but could be commercially viable in, perhaps, two years.

**Introduction of 2019 National Infrastructure Protection Plan Resilience Challenge**

At the conclusion of Dr. Padir’s presentation and question period, Eric Holdeman once again took to the stage to introduce the CRDR’s next NIPP Resilience Challenge grant project which will address using drones for synchronization of situational awareness. The goal of this project is to establish an access methodology for how public and private sector organizations gain access to their critical infrastructure following a disaster. This project applies to four states—Washington, Oregon, Montana, and Idaho. The CRDR will hold a workshop in each of the four states in conjunction with each state’s emergency management offices and develop a CONOPS for each state.

**Business Re-Entry (BRE) Registration**

Tristan Allen, Program Manager for Washington State Emergency Management, presented next on the Washington State system instituted to assist the private sector, primarily, to regain entry to their critical infrastructure or business following a disaster. This Business Re-Entry Registration (BRE) allows organizations to pre-register with the state to allow for quicker and smoother access to their infrastructure after a disaster. After an event, this system provides law enforcement or other entities quickly and easily verify that identify the organization and allow them access at their discretion. Mr. Allen walked the attendees through the process of eligibility, registration, and navigation of the system and explained that benefits of pre-registering through the system.

**NHERI RAPID Facility**

The last speaker of the day, Jake Dafni, Operations Manager for NHERI RAPID Experimental Facility at the University of Washington, gave an overview on the University of Washington’s NHERI RAPID Facility which is a National Science Foundation-funded organization. The NHERI (Natural Hazards Engineering Research Infrastructure) RAPID Facility is a field-based, reconnaissance-based facility. Mr. Dafni stated the mission of the facility is address the grand challenges to critical infrastructure and provide the public and private sector and communities with publicly available solutions. Community resilience and infrastructure resilience are the two main issues that the facility seeks to address. The specific purpose of the facility is to acquire, maintain, and operate state-of-the-art information collection
tools that can be utilized by the public and private sector to address challenges to infrastructure in their
communities. They provide advisory services as well as an option to collect data for communities if need
be. Otherwise, they provide the training and support to allow entities to collect the data for themselves
using the facility’s equipment and programs. The facility’s tools include survey equipment, LIDAR
scanners, drones, seismic instrumentation, wind and storm surge instrumentation, social science recon
equipment, imaging equipment, software and data processing tools, and more. Mr. Dafni then went into
more detail about the fleet of drones that the NHERI RAPID Facility maintains from smaller drones to
larger, industrial drones to a commercialized, LIDAR-scanning drone. Mr. Dafni finished by discussing
the real-world applications of the facility’s tools and operations and what direction it might take in the
future.

Next Steps
Transportation and utility inspectors in attendance agreed to stay connected with Dr. Padir as the
technology is refined and further developed. A project website for the technical work has been
established at http://www.coe.neu.edu/research/radar/index.html

PNWER will continue to facilitate the UAS Task Force/Users Group as we move toward the phase II
project in 2019. Similar groups will be set up on ID, OR and MT. Members will connect via conference
phone as well as in person during upcoming workshops and the scheduled drill in 2019. WSDOT will
continue to co-facilitate the group in Washington.

The current UAS Task Force/ Users Group members are listed on the next page.
<table>
<thead>
<tr>
<th>Organization</th>
<th>Name</th>
<th>Title</th>
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<tbody>
<tr>
<td>443 Consulting LLC</td>
<td>Ernie Hayden</td>
<td>Founder/Principal</td>
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<tr>
<td>Apex Engineering, PLLC</td>
<td>Aaron Blaisdell</td>
<td>Principal Land Surveyor</td>
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<tr>
<td>Applewhite Aero</td>
<td>Paul Applewhite</td>
<td>President</td>
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<tr>
<td>AUVSI Cascade Chapter</td>
<td>Tom Hagen</td>
<td>President</td>
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<tr>
<td>Big Bend Community College</td>
<td>Byron Noel</td>
<td>Program Coordinator</td>
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<tr>
<td>Big Bend Community College</td>
<td>Byron Noel</td>
<td>Unmanned Systems Program Coordinator</td>
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<tr>
<td>Center of Excellence for Aerospace &amp; Advanced Manufacturing</td>
<td>Sue Bradshaw</td>
<td>Program Director</td>
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<tr>
<td>Center of Excellence for Aerospace Advanced Manufacturing</td>
<td>Mary Kaye Bredeson</td>
<td>Executive Director</td>
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<tr>
<td>Central Kitsap Fire &amp; Rescue</td>
<td>Steven Davison</td>
<td>Training Officer</td>
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<tr>
<td>Central Pierce Fire and Rescue</td>
<td>Dale Benning</td>
<td>Training Captain</td>
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<tr>
<td>Central Washington sUAS</td>
<td>Keith Conley</td>
<td>Owner</td>
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<tr>
<td>Chehalis Centralia Airport</td>
<td>Brandon Rakes</td>
<td>Airport Operations Coordinator</td>
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<tr>
<td>Chicago Police Department</td>
<td>Kenneth Adair</td>
<td>Police Officer</td>
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<tr>
<td>City of Edmonds</td>
<td>Jeff Whatmore</td>
<td>GIS Tech</td>
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<tr>
<td>City of Redmond Fire Dept./EMD</td>
<td>Janeen Olson</td>
<td>Fire Program Coordinator</td>
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<tr>
<td>CITY OF SEATTLE DEPARTMENT OF TRANSPORTATION</td>
<td>KEN EWALT</td>
<td>CONCRETE MANAGER / EMERGENCY RESPONSE</td>
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<tr>
<td>City of Yakima</td>
<td>Sean Davido</td>
<td>Community Relations Specialist</td>
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<td>Amb. William H. Weiss, MA, JD</td>
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<td>Cowlitz and Wahkiakum County DEM</td>
<td>Dave</td>
<td>Basham</td>
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<td>Disaster Medicine Project</td>
<td>Robert Mitchell, MD</td>
<td>Director of Community Disaster Medicine</td>
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<tr>
<td>Eagle-Eye Aerial Solutions, LLC</td>
<td>Sam Adams</td>
<td>Owner</td>
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<tr>
<td>End State Solutions LLC</td>
<td>Charlton Evans</td>
<td>Principle</td>
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<tr>
<td>Forming a LLC for business</td>
<td>Barbara Carson Hamer</td>
<td>CEO</td>
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<tr>
<td>Graham Fire &amp; Rescue</td>
<td>Shawn Gregory</td>
<td>Firefighter/Paramedic</td>
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<tr>
<td>Graham Fire and Rescue</td>
<td>Derick Soland</td>
<td>Firefighter/EMT</td>
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<td>Green Hippo Drones</td>
<td>Tad Doviak</td>
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<td>Hensel Phelps</td>
<td>Carlos</td>
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<td>Jefferson County</td>
<td>Matt Stewart</td>
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<td>King County</td>
<td>Cameron Satterfield</td>
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<td>KING-5</td>
<td>TEGNA</td>
<td>Greg Thies</td>
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<tr>
<td>Lakewood Police Department</td>
<td>Mike McGettigan</td>
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<td>Lakewood Police Department, WA</td>
<td>Austin Lee</td>
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<td>Macedonia VFD</td>
<td>Cody Dailey</td>
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<tr>
<td>Mason County Sheriff's Office</td>
<td>Michael Sargent</td>
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<tr>
<td>Montgomery County, Kansas - Office of Emergency Management</td>
<td>Lee Miller</td>
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<td>Multnomah County</td>
<td>Edwin Lopez</td>
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<td>Multnomah County Transportation Division</td>
<td>Tina LeFebvre</td>
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<td>Olympic College</td>
<td>Terry M. Reddick</td>
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<td>Oregon Department of Transportation</td>
<td>Christopher Glantz</td>
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<tr>
<td>Pacific County Emergency Management Agency</td>
<td>Scott McDougall</td>
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<td>Pegasus Imagery Ltd</td>
<td>Cole Rosentreter</td>
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<td>Pierce College, Fort Steilacoom</td>
<td>Morgan J Walker</td>
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<tr>
<td>Port of Seattle</td>
<td>Russ Read</td>
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<td>Port of Vancouver, USA</td>
<td>Todd Krout</td>
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<tr>
<td>PORT Townsend Police Department</td>
<td>William Corrigan</td>
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<tr>
<td>Puyallup Police</td>
<td>Greg Massey</td>
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<td>Puyallup Police Department</td>
<td>Jason Visnaw</td>
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<tr>
<td>Rogue Heart Media</td>
<td>Mike Robison</td>
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<tr>
<td>Seattle Department of Transportation</td>
<td>Patti Quirk</td>
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<tr>
<td>Skagit County Public Works</td>
<td>David Walde</td>
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<tr>
<td>Snohomish County</td>
<td>Ed Whiford</td>
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<tr>
<td>Snohomish County Department of Emergency Management</td>
<td>Robert Thurston</td>
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<tr>
<td>Snohomish County Public Utility District</td>
<td>Maureen Barnes</td>
<td>Real Estate Manager</td>
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<tr>
<td>Snohomish County Volunteer Search &amp; Rescue</td>
<td>Larry D. Warner</td>
<td>Remote Pilot Volunteer</td>
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<tr>
<td>Syracuse(NY) Fire Department</td>
<td>Timothy Gleeson</td>
<td>Captain</td>
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<tr>
<td>Tacoma Police Department</td>
<td>Scott A Harris</td>
<td>PPO</td>
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<tr>
<td>Tacoma Public Utility</td>
<td>Jason Stewart</td>
<td>Senior Management Analyst</td>
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<td>The Ulven Companies</td>
<td>Steve Fournier</td>
<td>VP Sales and Marketing</td>
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<td>Thurston Co. Public Works</td>
<td>Jim Moyer</td>
<td>Tech 2</td>
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<tr>
<td>Thurston County Public Works</td>
<td>Matt Baider</td>
<td>Assistant Design Engineer</td>
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<tr>
<td>Washington Department of Natural Resources</td>
<td>Abby Gleason</td>
<td>Lidar Manager/ITS4</td>
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<td>Washington State County Road Admin Board (CRAB)</td>
<td>Jim Ayres</td>
<td>Engineering Design Systems Manager</td>
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<td>Washington State Patrol</td>
<td>Jay Cabezuela</td>
<td>Captain</td>
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<tr>
<td>Wolf UAS, LLC</td>
<td>Mitch Droz</td>
<td>VP of Operations &amp; Customer Experience</td>
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<tr>
<td>Yakima Police Department</td>
<td>Tory Adams</td>
<td>Sergeant</td>
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### Using Drones to Detect Damage to Bridges Workshop Agenda

**December 13, 2018 | 8:30am-12:00pm**  
Clover Park Technical College- Lakewood, WA

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8:30am</td>
<td><strong>Registration</strong></td>
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<td>Pastries and coffee provided.</td>
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<td>9:00-9:15</td>
<td><strong>Welcome and Introductions</strong></td>
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<tr>
<td>9:15-9:30</td>
<td><strong>Review of NIPP Project</strong></td>
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<td>Eric Holdeman, Director of Center for Regional Disaster Resilience</td>
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<tr>
<td>9:30-10:00</td>
<td><strong>Update on Drone Regulations and Usage in the Pacific Northwest</strong></td>
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<td>Tom Hagen, President of Association for Unmanned Vehicle Systems</td>
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<td>International Cascade Chapter</td>
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<tr>
<td>10:00-10:10</td>
<td><strong>Break</strong></td>
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<tr>
<td>10:10-11:00</td>
<td><strong>Report on Technical Tools for Post-Disaster Damage Assessment</strong></td>
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<tr>
<td></td>
<td>Taskin Padir, Associate Professor of Electrical and Computer Engineering</td>
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<td></td>
<td>at Northeastern University</td>
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<td>11:10-11:20</td>
<td><strong>Using Drones for Synchronization of Situational Awareness: Introduction of Next Project</strong></td>
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<td></td>
<td>Eric Holdeman, Director of Center for Regional Disaster Resilience</td>
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<tr>
<td>11:20-11:40</td>
<td><strong>Gaining Access for Critical Infrastructure Inspections in Washington</strong></td>
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<td>Tristan Allen, Program Manager for Washington Emergency Management</td>
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<td>11:40-12:00</td>
<td><strong>RAPID Facility Overview</strong></td>
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<td>Jake Dafni, PhD, PE, Operations Manager for NHERI RAPID Experimental</td>
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<td></td>
<td>Facility at the University of Washington</td>
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<td>12:00</td>
<td><strong>Adjourn</strong></td>
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Workshop
December 13, 2018
Lakewood, WA

Participants List

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