NEVADA FAA UAS TEST SITE QUARTERLY REPORT

June 30, 2016

2nd Quarter, CY16

Submitted in accordance with Other Transactional Agreement DTFACT-14-A-00003

Prepared by:

Nevada Institute for Autonomous Systems

for

The Nevada Governor’s Office of Economic Development
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NEVADA UAS TEST SITE QUARTERLY REPORT

2nd Quarter 2016

Date Submitted: 29 July 2016

Calendar Quarter Ending: 30 June 2016

Name: FAA-designated Nevada UAS Test Site

POC’s & Contact Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Information</th>
</tr>
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<tbody>
<tr>
<td>Chris Walach</td>
<td>Director of Operations for Unmanned Aviation, NIAS &amp; the FAA-designated Nevada UAS Test Site</td>
</tr>
<tr>
<td>Mark Barker</td>
<td>Director of Business Development, NIAS &amp; the FAA-designated Nevada UAS Test Site</td>
</tr>
<tr>
<td>Brett Kanda</td>
<td>Business Operations Manager, NIAS &amp; the FAA-designated Nevada UAS Test Site</td>
</tr>
<tr>
<td>Nevada Institute for Autonomous Systems (NIAS)</td>
<td>6795 Edmond Street, Suite 300 Las Vegas, NV 89118</td>
</tr>
<tr>
<td>Tom Wilczek</td>
<td>Industry Specialist Aerospace &amp; Defense Representative and Nevada POC for the Nevada UAS Test Site</td>
</tr>
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Table 1 POCs and Contact Information

DAR & Contact Information:

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Michael Schiefer</td>
<td>Nevada UAS Test Site DAR</td>
</tr>
<tr>
<td></td>
<td>1087 Mesa Verde Ct Clermont, FL 34711</td>
</tr>
<tr>
<td></td>
<td>(o) No office phone—off site employee</td>
</tr>
<tr>
<td></td>
<td>(c) 410-935-1336</td>
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</table>

Table 2 Test Site DAR and Contact Information

EXECUTIVE SUMMARY

According to the Other Transaction Agreement (OTA) between the Federal Aviation Administration (FAA) and the State of Nevada, DTFACT-14-A-00003, Modification 0001, May 19, 2014, the State of Nevada FAA Unmanned Aircraft Systems (UAS) Test Site submits the
following as the Quarterly Report for the second quarter of 2016. The content in this report is an outline summary of the Nevada Test Site activities over the past 90 days through 30 June 2016.

The Nevada Governor’s Office of Economic Development (“GOED”) is the lead Nevada state entity for interface and coordinating with the FAA UAS PMO for developing and integrating the FAA’s UAS Systems under the OTA. In turn, GOED has contracted to the non-profit Nevada Institute for Autonomous Systems (NIAS) to operate and oversee the daily operations and management over the designated test site ranges, Nevada airspace development, and UAS Industry business lead generation. The NIAS, in turn, is staffed with permanent members to provide management of the daily test site operations on behalf of GOED. The Governor’s Office of Economic Development and NIAS personnel are hereinafter referred to collectively as (“Nevada personnel”) in this report. Nevada personnel have begun to ramp up the Nevada Industry growth to keep pace with the global UAS Industry growth. Nevada is on a positive path to posture Nevada as the global location of choice for unmanned testing and training, R&D, and publicly oriented operational unmanned aviation projects and flight missions.

Following an increasing 1st Quarter operational tempo, 2nd Quarter operational tempo continued at unprecedented flight operational levels. New testing and developmental profiles included counter unmanned aviation, advanced package delivery, and cloud seeding. These new UAS categories will unquestionably position Nevada on a positive course to lead global UAS expansion. The recently approved FAA Extension, Safety, and Security Act of 2016, July 16th, 2016 and the extension of the FAA UAS designation of the Nevada UAS Test Site until September 30, 2019 both validate and reinforce the six FAA-designated UAS Test Sites contributions toward testing and development activities and advancing the UAS Industry toward open and safe National Airspace integration.

**ACCOMPLISHED ACTIVITIES DURING 2nd QUARTER, 2016**
(*REPORTABLE IN THE COA ONLINE SYSTEM*)

During the 2nd Quarter, CY 16, the FAA online reporting system recorded 306 COA flights for the FAA-designated Nevada UAS Test Site representing a 109% increase from 1st Quarter totals (139 COA flights). The aggregate COA total to date as of 30 June, 2016 is 512 COA flights. Two weeks into the 3rd Quarter, the Nevada UAS Test Site has already completed 52 COA flights. At this operational tempo, NIAS is on track to surpass 700 COA flights through the 4th Qtr, CY 16. This would approximately represent a 900% increase from CY 15 COA totals.

<table>
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<th>Date</th>
<th>Total COA Complete</th>
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<td>HADM/Hawthorne, NV</td>
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<td>5/12-13/2016</td>
<td>7</td>
<td>Redmond, WA</td>
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<tr>
<td>Pah Rah Petroglyphs/NAASIC C2</td>
<td>5/20/2016</td>
<td>10</td>
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<tr>
<td>Insitu/Boeing/NAASIC C2</td>
<td>5/26/2016</td>
<td>21</td>
<td>Reno, NV</td>
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<tr>
<td>Insitu/Boeing/NAASIC C2</td>
<td>6/2/2016</td>
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<td>Reno, NV</td>
</tr>
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Table 3 – 2nd Quarter Air Missions Completed
In addition to the Nevada UAS Test Site increased flight activities and data collection for the 2nd Quarter, Nevada personnel are also reporting these additional activities:

- The Nevada UAS Test Site did not submit any 2nd Quarter FAA COA applications; however, Nevada personnel chose to focus on maximizing active COAs and conducting initial preparations for beyond visual line of sight (BVLOS) safety case planning, analysis, and initial development. The Nevada UAS Test Site received FAA approval for two Santa Cruz, CA COAs submitted during 1st Quarter. Current COAs submitted to the FAA and in the cue for approval include: Silver Springs, Tiger Airfield, Beatty, and Tonopah Airports. The Nevada UAS Test Site is waiting on FAA approval for its submitted 333 Exemption since April 2016.
- The Nevada Test Site continues to work with its Nevada Teammates on testing innovative UAS cloud-seeding applications focused on increasing snowpack depths in the Lake Tahoe, Nevada region.
- As the National Airspace becomes more assessable for commercial Part 107 UAS operators, preventing unauthorized flight around towered ATC commercial airports, sensitive government, and military complexes increases the importance of having available and capable counter-UAS Nevada Test sites. In preparation for this new industry demand, the Nevada UAS Test Site has pursued new lines of counter-UAS flight testing.

### NIAS Business Development

2nd Quarter training and testing flights with Embry Riddle, the Nevada Clouding Seeding project, and the NASA UTM team produced several UAS media opportunities across the State of Nevada.

**Business Development**

1. NIAS formalized an agreement with a large energy company to conduct proof of concept UAS flights for power line survey and inspection. Ultimately, if the results are acceptable, real world projects could be possible in the future as BVLOS UAS survey flights become a reality.

2. NIAS collaborated with several counter-UAS companies interested in testing their new technology at the Nevada UAS test site. NIAS is working through various UAS range options for cUAS testing to include creating the ability to test non-lethal and lethal counter-UAS operations.

**Educational Outreach.** UAS flight training continued with instructors from Truckee Meadows Community College

**Marketing.** NIAS completed the development of a new interactive entrepreneur website. The launch date is planned for July 2016. Other NIAS marketing activities include:

1. NIAS Social Media Sites; LinkedIn, Twitter, and Facebook were launched in June 2016.
2. NIAS, GOED and several Nevada Teammates exhibited at the AUVSI 2016 annual meeting May 2016.
3. NIAS relocated its corporate headquarters to Switch’s Innovation Center in Las Vegas.

**NASA-NIAS UTM Update**

The Nevada-NASA team includes: GOED (PI), NIAS (operational control and NASA PMO), Reno-Tahoe Airport Authority (RTAA), UNR, and GC2IT. The Nevada-NASA team has successfully completed UTM Phase Build 1 with Build 2 scheduled for roll out and operational testing in October 2016.

NIAS and NASA co-signed a Space Act Agreement to formalize support of the NASA Unmanned Traffic Management (UTM) platform and other future research and development Operational Test and Evaluation (OT&E) platforms and programs. The Nevada-NASA team collaborated with the NASA-Ames to successfully plan and fly 32 UTM missions in support of the UTM-TCL1 “National Campaign” test flight demonstration on 19 April 2016. The Nevada-NASA team flew a total of 32 UTM nationally coordinated test missions in support of the NASA OT&E demo event – twice as many missions as any other of the six test sites, and has earned the distinction as the test-site-of-choice for the NASA UTM and other NASA R&D OT&E flight test requirements, including UAS Beyond-Visual-Line-of-Sight (BVLOS) and Sense and Avoid development and testing. Collectively with the NASA planners and UTM leadership, the Nevada-NASA team has made the TCL2 “shakedown” tests at Reno-Stead 27-30 June 2016 a highly successful operation. The Stead Airport staff were instrumental in preparing their airport facilities, the Nevada UAS Test Site Range, and providing NASA personnel daily logistic support.

**NUANCE Lab:** NASA indicated that we were first of the six Test Sites to complete the System Security Plan (SSP), and the first team to have the pre-connection design meeting with NASA. This marks a significant milestone in the development of the NUANCE Live-Virtual-Constructive Distributed Environment (LVC-DE) Gateway capability given the absence of any existing infrastructure at the start of the SSP process.
PLANNED AND EXECUTED RESEARCH PROJECTS BY INSTITUTION

Desert Research Institute (DRI)

The Desert Research Institute is continuing to pursue UAS applications research, development and collaborations. Some of the highlights are discussed below by topic area.

Current Research and Development Activities

UAS Agriculture Research Application: The Nevada Governor’s Office of Economic Development (GOED) funded a project entitled: Development of Unmanned Aircraft System (UAS) for Agricultural Applications on April 1, 2016. The goals of this project are to acquire and analyze UAS visible (RGB), near infrared and thermal infrared image data to assess variances in field and crop conditions due to pests, disease, environmental conditions (e.g., saline soils) and irrigation inefficiencies. The project was initiated at the beginning of April and several UAS flights were conducted on June 9th by the project’s business partner, AboveNV. Both fixed wing and rotor platforms were deployed to acquire RGB, near infrared and thermal infrared imagery of agricultural fields, both platforms are depicted in Figure 1.

Although the focus of this project is to develop image products that are of value to the farm manager (see examples in Figure 2), DRI is also examining efficiencies in UAS operations and image acquisition. To expand UAS operations for this project, DRI and AboveNV are working with the Nevada Institute for Autonomous Systems (NIAS) to become a NIAS Node. This will expand our opportunities for UAS operations at other locations.

Figure 1: AboveNV pilot, Rob Dunbar, launching the fixed wing platform to acquire near infrared imagery of a pea field (left) and performing a pre-launch safety/operations check prior to launch of a hex-rotor platform carrying a thermal infrared camera.
UAS Cloud Seeding: To date a team consisting of DRI, AviSight, and Drone-America have conducted several flight tests to provide cloud-seeding capabilities to unmanned aircraft. The first of their kind, these operations promise to reduce the inherent risks involved in utilizing aviation assets for cloud seeding, while providing drought resilience and potentially augmenting regional water supplies. Flights have been conducted with the collaboration of the Nevada Institute for Autonomous Systems (NIAS) and under the authority of the FAA’s Nevada UAS Test Site, where DRI is a Test Site Node.

UAS Wildfire Applications: Development of capabilities for UAS to provide information relevant to wildland fire research and supporting fire-response operations continues. Most recently, the multi-agency Fire and Smoke Model Evaluation Experiment (FASMEE) provides an opportunity to exercise these capabilities in the context of the largest suite of wildland fire experiments to date, and DRI’s personnel and their collaborators hope to provide leadership in the areas of airspace coordination as well as technical and scientific capabilities.

New and Future Research and Development Activities

DRI, UNLV and UNR faculty are continuing discussions to prepare a National Science Foundation (NSF) EPSCoR pre-proposal for a $20 million effort to grow UAS and autonomous systems infrastructure within the state.

Lessons Learned

UAS Agricultural Research Application: The primary lessons learned to date for this newly initiated activity include:

1. The hex-rotor platform is performing better under typical afternoon NV wind conditions than anticipated;
2. Image pre-processing time and accuracy will be enhanced after AboveNV completes a hardware/software engineering effort to directly link the UAS platform GPS metadata file with the camera photographs.

3. Efficiencies in deploying ground validation targets are being addressed by comparing inexpensive white vinyl tiles (12” by 24”) and targets created using marker spray paint (glo-orange). Rapid deployment of ground calibration targets must be achieved to ensure that each agricultural field has demarcated ground targets prior to UAS flight operations.

   **UAS Cloud Seeding**: Lessons learned include the high value that teamwork contributes to this project. In addition to Reno-based Drone America and Las Vegas-based AviSight providing critical capabilities for this project, the Hawthorne Airport and NIAS have contributed expertise and support that have enabled this GOED-funded project to achieve ambitious milestones.

   **UAS Wildfire Applications**: With both the rapidly-changing regulatory landscape and the presence of “problem” hobbyist UAS on nearly every major wildland fire recently, clearly communicating the message of UAS integration into wildland fire operations and research has become more difficult due to the challenge of presenting a message that acknowledges these fluid situations which can sometimes result in distractions from key messages of UAS utility in fire. A lesson learned so far in this project is that fire management agencies are increasingly willing to consider UAS use, but our role in the UAS community of educating the public about the hazards of incursions into restricted airspace is considered to be integral to the future potential of these important tools.

   **Research Highlight**: The opportunity to achieve an aviation first—operating a cloud-seeding payload from an autonomous UAS—has been sought by DRI and partner Drone America, but finally realized as a result of support from the NV Governor’s Office of Economic Development. Along with the capabilities of AviSight and the collaboration with NIAS, we expect to continue advancing UAS technology for a second season this winter. Our continued operational tests will demonstrate seeding during winter precipitation events, and we hope to include regular beyond-line-of-sight flights as we continue to prove the reliability and safety of our systems under expanding ranges of environmental conditions. We also hope that our expanded operations will provide opportunities for citizen science and economic development to support areas where we operate, while highlighting Nevada’s burgeoning UAS industry and increasing the water security of the areas we serve.

**UAS Flight Activities**

**UAS Agricultural Research Application:**

On June 9, 2016, six UAS flights were conducted to meet the mission for that day. The focus of the UAS operation was to acquire RGB, near infrared and some thermal infrared imagery of three 130 acre agricultural fields; one with a pea crop and two with alfalfa. The flights occurred between the hours of 7:30 am (thermal camera) and 2:00 pm. Flights were discontinued at approximately 2 pm because of the increase in wind gusts (typical for summers in NV) and the development of dust devils. All flights began with a complete system check of hardware and software for both the platform and the sensors. Visual observers verified that conditions were appropriate for launch (weather and flying birds) and that all safety protocols were followed. Take-off and landings were performed manually by the pilot and image acquisition was performed
autonomously by a pre-defined flight plan that was uploaded to the UAS platform.

The only significant research and development lesson learned from these flights was that cloth ground targets did not perform well. Targets were moved/lost due to dust devils and gusts as well as ground squirrels dragging targets into their burrows.

**University of Nevada Las Vegas (UNLV)**

UNLV focused on or are working several UAS projects simultaneously:

1. Enhanced Situational Awareness Using Unmanned Autonomous Systems for Disaster Remediation ($600,000, NSF, Yim in collaboration with UNR and Univ. of Utah).
2. Infrastructure for Enabling Mobile Manipulation Unmanned Aerial Vehicle (MM_UAV; Research and Design, $256,000, P. Oh, NSF).
3. Development of Agile and Robust Consequence Monitoring System ($310,000, W. Yim, Sandia National Labs).
4. The Flying Orchestra: A Flying Aerial Robot Live Entertainment System. We plan to work on developing an indoor tracking system for coordinating multiple drones and visualizing musical signage while flying ($92,000, S. J. Kim and P. Stuberrud—with Skyworks; Governor's Office of Economic Development).
7. Low-Cost Multiple Unmanned Aircraft System for Remote Contour Mapping of a Nuclear Radiation Field ($48,000, P. Oh, NSTec).
10. Development of Unmanned Aerial System with Plug-and-Play Interchangeable Sensor Components and Mobile Manipulation Capability. To address the needs of remote sensing and sampling applications, we are developing UAS with plug-and-play interchangeable components: (1) neutron/gamma radiation sensor, (2) gas sensor, and (3) miniature manipulator. The remotely-controlled octocopter with 6.8-kg payload is equipped with the onboard devices (a
LIDAR, Lepton FLIR sensor, Pixhawk flight controller, and a 3DR radio transceiver) and the add-on components. The CLYC radiation sensor allows simultaneous neutron and photon measurements with effective signal discrimination. The electrochemical gas sensor enables a real-time pattern recognition analysis of gases in air. The manipulator enables interaction with the environment such as sample collection and handling, supported with the adaptive UAS control schemes. The plug-and-play interface enables easy attachment of components in the field conditions (Woosoon Yim—Co-PI and Alexander Barzilov—PI).

Fig. 1. UAS platform with plug-and-play components.

(a) (b)
Plug-and-play, add-on UAS components:
(a) CLYC detector assembly; (b) gas sensor board.

Neutron/photon PSD analysis for CLYC sensor.
UNR focused on or are working several UAS research projects simultaneously including:

1. Dr. Richard Kelley continues to be very involved in the NASA UTM project with software development and testing. NASA will be returning to Reno at the end of June for the UTM TCL-2 software checkout #2.

2. The grand opening of the Nevada Unmanned Aircraft and NextGen Collaborative Environment Laboratory (NUANCE) Lab at Reno-Stead airport was held on April 6, 2016. This event was coordinated by the Reno-Tahoe Airport Authority and attended by Governor Brian Sandoval, UNR Administrators, NASA representatives, GC2IT, Flight Research Assoc., and NIAS.

3. NAASIC hosted the first annual Search and Rescue (SAR) Symposium from April 6-8. There were 12 speakers, a discussion panel, and 2 breakout sessions that covered topics from Advanced Search Techniques with Drones to Sensor Technologies and Beyond Line of Sight. Nearly 100 people attended from across the country as well as many first responders from Washoe County, NV and neighboring counties. NAASIC will host this conference again next year.

4. UNR is an Insitu Registered Software for Training member and is offering an undergraduate course on the Insitu ICOMC2/Inexa ground control software and Integrator plug-in applications in the Department of Engineering in fall 2016. Insitu visited the UNR campus on June 5-8, 2016 to train 3 UNR Engineering faculty and 2 NAASIC staff members on the use and instruction of ICOMC2/Inexa. The course will be part of the UAS minor curriculum at UNR.

**Featured Research Project.** NAASIC was instrumental in the successful execution of the NASA UTM Project Task 1 Initial Safe National UAS integration Campaign/Initiative for the State of Nevada UAS Test Site. Dr. Kelley and his team of undergraduate students worked for months developing, implementing, and testing the UTM software for integration of UAS in the NAS. Each test site location at the Reno-Stead Airport UAS Range was required to have four aircraft in the air for the test, so NAASIC purchased two new platforms and partnered with the UNR Hydrogeology UAS team to use two of their platforms. NAASIC assembled the ground crew, which included two Nodes, and four PICs, Vehicle Operators, GCS Operators, VOs, and volunteers to record the flight data. The flight crew complied with COA regulations and completed the Crew Resource Management Training and obtained their Class II medical certificates. NAASIC, with the help of the RTAA, handled other logistics, such as ensuring that the north and south test sites each had tents, tables, chairs, generators, extension cords, power strips, emergency supplies, and water. NAASIC also provided labelled volunteer vests, radios, clipboards, and FAA data sheets to the operators, VOs and volunteers. A dress rehearsal was conducted on Friday, April 15, from 9am to 1pm and the National Campaign flight operations took place from 9am-12pm on Tuesday, April 20. NAASIC compiled the Range Operations Book and submitted the completed FAA data sheets to NIAS.
The NASA National Campaign was NAASIC’s most complex flight operation to date. Although there were a few small software issues during the test (it was a test after all), NAASIC was extremely pleased with the outcome. Communication between the PICs, flight crew members, NIAS, and NASA went smoothly. The weather was optimal for the flying UAS and 32 COA flights were completed. We owe the success of the operation to the many partners and volunteers who contributed their time and efforts, but especially to Dr. Kelley for his technical contributions and for training the undergraduate students who were at the controls.

From Left to Right: Eduardo Espinoza Quesada, Duncan Wilson, Cami Bourquin, Niki Silveria, and Sierra Adibi.

**Flight Activities.** NAASIC provided mission coordination to Insitu, a Boeing subsidiary, for testing of their new Ground Control System, ICOMC2/Inexa. Test flight operations took place at the Reno Radio Control Club on April 3-4, May 5-26, and June 2. NAASIC coordinated test flights for graduate students and faculty in the UNR Dept. of Anthropology to conduct aerial surveys of archaeology sites on BLM property just north of Reno. NAASIC provided the aircraft and crew for the BLM flights on 5-20-16. Data processing for these missions is ongoing. NAASIC is also collaborating with the UNR Dept. of Anthropology to map the Ft. Churchill State Historic Site with UAVs. These flights were scheduled for 5-24-16, but have been postponed until next quarter. NAASIC provided support for Ausley and Assoc./Carbon Autonomous by conducting an Airworthiness review and evaluation with NIAS on 3 different UAS platforms on 6/10/2016.

Susan Welsh (4th from left) and the InSitu ICOMC2 flight test crew.

**Lessons Learned.** The biggest challenge to flying UAVs in Nevada is the process of gathering all of the required FAA flight documents. It is sometimes a challenge for our customers to submit the documents to us in a timely fashion. Solution: a firm, but gentle approach and plenty of lead time.
NEVADA UAS TEST SITE CHALLENGES

The Nevada State and Nationwide UAS operations significantly raised the aggregate COA flights this quarter. NIAS has extended its flight operations under the nationwide blanket COA into Washington, California, and Florida. The increased flight activity produced critical lessons learned, which Nevada personnel will implement into future operational missions. The FAA announcement of the UAS operators Part 107 release the end of August 2016, the FAA Extension, Safety, and Security Act of 2016 signed into law July 16th, and the extension of the Nevada UAS Test Site’s FAA designation to September 30, 2019 all will produce positive future developments for the Nevada UAS Industry. Nevada UAS Industry continues to transform and grow at a near reciprocal pace as the global UAS industry. The pace of the Nevada Industry growth often outpaces existing NIAS resources necessitating the need to continually reprioritize personnel and critical resources to keep pace with the growth. Agile and resilient, NIAS is unique in the State of Nevada and is the primary agency given this industry-wide strategic growth mission. The Nevada Teammates and network of supply vendors interact with NIAS to help accomplish this strategic mission. All combined, Nevada remains resilient to unanticipated future FAA UAS challenges.

SUMMARY

Nevada personnel have surpassed operational 2nd Quarter milestone flight projections by a wide-margin and will continue to accelerate the Nevada UAS Industry growth by increasing COA flights, opening up airspace opportunities to Nevada Teammates and NIAS command and control (C2) nodes, and generating or stimulating the Nevada UAS business leads. Nevada personnel continues to advance research projects across multiple UAS disciplines including Cloud Seeding, counter-UAS, Urban Package Delivery, and Consumer Drone Safety establishing Nevada as a global thought leader in these areas. Teaming with Embry-Riddle Aeronautical University Worldwide Campus on their first-ever comprehensive consumer guide to small unmanned aircraft systems (sUAS) for novice users will benefit the global UAS Industry in the areas of safety awareness and operational use. Nevada personnel have begun collaborating with several city municipalities to advance the concept of the UAS Economic Cluster Zones throughout Nevada. These efforts will benefit Nevada UAS businesses by ensuring viable work projects and continual business growth quarter-over-quarter.

The Embry-Riddle sUAS Consumer Guide can be found at: