STATE OF IDAHO
UNMANNED AIRCRAFT SYSTEMS
INVENTORY

State of Idaho UAS Inventory Summary

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FAA UAS Test Site Selection Strategic Competitive Analysis ©

Compiled from various sources by Advanced Aviation Solutions, LLC

Current as of April 2013

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State of Idaho UAS Inventory Summary ©

Advanced Aviation Solutions, LLC

Introduction

In February, 2013, the Idaho Department of Commerce commissioned Advanced Aviation Solutions, LLC, to conduct an inventory of the State's unmanned aircraft system (UAS) resources with a goal of identifying current assets, as well as possible areas for expansion that hold the greatest potential. This document outlines the results of that inventory, and demonstrates that Idaho has a solid foundation in UAS operations, research, and testing. Combined with the galvanizing power of the State Government, it is very possible to expand those strengths into a national UAS Center of Excellence (COE) and a source of considerable job and revenue growth for the state.

The FAA's Priority UAS Research Areas

Shortly after this inventory began, the Federal Aviation Administration (FAA) released a screening information request (SIR) focused on furthering UAS integration into the National Airspace System (NAS) with a goal of awarding six UAS test site designations to the most qualified applicants. The SIR lists six of the FAA's highest priority UAS integration research areas. ADAVSO has evaluated these focus areas with particular attention paid to Idaho's strengths and weaknesses in each.

The first desired research area deals with UAS command and control link reliability and security. Its focus is on ensuring the method by which a pilot sends command and control messages to the unmanned aircraft is reliable, secure, and resilient. Idaho has a tremendous advantage when considering UAS command and control link issues, especially related to security. Idaho State University operates one of the nation's top cyber security programs and maintains contracts with several Federal agencies to conduct security research. Applying this expertise toward securing UAS command and control links to help prevent unintentional or intentional jamming, spoofing, or hijacking of an unmanned aircraft is critical to the future of the industry. Additionally, the Idaho National Laboratory (INL) is currently conducting research into intelligent link management systems that can compare actual signals to expected signals, then identify and auto-correct observed discrepancies. INL's experience with operating many UAS from their FAA-approved airspace provides an extensive framework for continued and expanded testing to be done today in a safe, secure environment. Advanced Aviation Solutions brings many years of military-based UAS operations experience to Idaho, and has considerable relevant experience with command and control link reliability and security stemming from tactical employment in remote, austere, and contested electromagnetic environments. Beyond UAS-specific experience, all major Idaho universities operate computer science and design programs, and many departments have already accomplished some work on UAS research and development topics. Encouraging these programs to focus on areas supporting an Idaho UAS COE will only promote Idaho as a state on the cutting edge of aviation development.

The second FAA focus area is UAS ground control station layout and certification. Ergonomics, safety, security, programming, networking, avionics design, and human factors engineering all contribute to control station layout and certification essential to commercial UAS development. Current UAS ground control stations tend to focus almost entirely on basic utility, with little regard for UAS pilot comfort or efficient and effective monitoring or interaction with the aircraft. There is a notable need within the industry to bring UAS control stations to a level equivalent to that expected of manned aircraft flight decks in order to make commercial UAS and airspace integration viable. With a robust Human Factors Engineering program, the University of Idaho is well positioned to further UAS ground control station research and design. Additionally, Boise State University has already contracted with the FAA to conduct research into commercial aircraft cabin air quality, an experience that could easily parlay into UAS ground station environment studies of a similar nature. Advanced Aviation Solutions has a human factors engineer on staff and over two years of experience developing the next generation RQ-4 Global Hawk UAS ground station for the Department of Defense. Support for further development of the University of Idaho Human Factors Engineering program, and potential commercialization of offshoots of Boise State University's FAA-sponsored research would directly support the burgeoning UAS industry in Idaho.

A critical component of the FAA's efforts to integrate UAS into the US NAS is development of autonomous sense and avoid technology. The goal of such technology is to enable UAS to detect potential hazards, such as terrain, obstacles, or other aircraft, and then maneuver to avoid the hazard either autonomously or via pilot commands. Sense and avoid research to date has taken a broad, and largely unfocused approach, with a lot of resources from many different agencies being dedicated just to defining requirements, hardware needs, and a number of potential methods. However, despite such efforts, the FAA has yet to establish any official policy or requirement for sense and avoid systems. Similarly, the FAA also hasn't defined a minimum measure of detection, separation, or safety for sense and avoid systems to comply with, which has largely stalled commercial hardware and software development as they lack a specification to design to. The closest analogy to UAS sense and avoidance work being done in Idaho resides in computer science departments – none of which have specific work being done on the topic. Central to computer science work is advanced programming, with most programs focused on topics such as artificial intelligence programming, neural network programming, and path-finding – all of which are foundational to development of UAS sense and avoid systems. Due to the immaturity of UAS sense and avoid policy and guidance, as well as the considerable amount of research already being done, largely funded by the Department of Defense, we would not recommend the State of Idaho specifically invest significant resources towards such endeavors. However, by establishing a UAS COE, the potential exists to attract considerable federal funding or grants, as well as attract commercial companies researching sensors and sense and avoid technology, especially once the FAA further defines policy and requirements. The long-term potential commercial upside is high.

UAS airworthiness certification is the next major FAA research area. The primary objective will be to examine existing manned aircraft certification regulations, then capture, compile and integrate UAS-specific considerations in order to expand current aircraft certification requirements to effectively incorporate UAS. Idaho has strength in this arena with Idaho State

University and North Idaho College, both of which operate aircraft maintenance programs and are looking to expand into unmanned aircraft maintenance, certification, and airworthiness as commercial systems come online. With a 121% increase in enrollment in ISU's program alone, the growth in this area is evident. Due to the impact on public and aviation safety, UAS airworthiness standards and certification are critical topics to the FAA, but they are unlikely to translate into significant commercial development potential since ownership of any intellectual property will likely remain with the Federal government. However, by influencing development of airworthiness certification standards and staying on the leading edge of advances on this topic, especially through the development of a UAS COE, Idaho can lead the nation in creating certified craftsman to support the nation's UAS maintenance needs as commercial UAS begin flying.

The FAA has also included unmanned system safety monitoring and data gathering as a potential UAS Test Site focus area. Due to the remotely-piloted nature of UAS, timely and accurate system monitoring and data display is essential to safe flight operations and airspace integration. Additionally, robust and accurate data collection is essential to UAS research and development, as well as NAS integration, efforts. As a federally-chartered research entity, INL has a long and established data gathering and processing history. They also maintain one of the nation's longest standing non-military Certificates of Authorization for UAS operations in the United States. Since inception, the INL UAS program has emphasized safety and developed considerable system monitoring methods and technology, and they have the flight record to show it. Additionally, they've developed robust data gathering techniques in order to accomplish their research and development efforts. Expanded emphasis in this area would involve supporting Idaho universities to bring their research and development efforts, processes, and experience to contribute to this effort. With the combined efforts of INL and Idaho universities, as well as resulting potential commercial development opportunities, an Idaho UAS test site could serve as a focal point in the system monitoring and data collection arena with the potential to attract considerable outside interest, investment, and sensor and technology companies to the state.

The sixth FAA focus area for UAS testing involves the positive or negative environmental impact of UAS operations. This topic ranges from potential impacts the UAS themselves may have on the environment to how they might be used to contribute the environmental monitoring and research. Advanced Aviation Solutions is confidant the reduced requirement for onboard comfort and life support systems, as well as energy-saving aviation and power technologies that UAS potentially enable, can significantly benefit the environmental footprint of the aviation industry over the long term. More immediately, UAS can be used for environmental monitoring. In fact, they're already being used for that exact purpose within Idaho. The University of Idaho uses UAS for arboreal research and public outreach programs. Their methods and techniques can easily be expanded to other avenues, such as forest monitoring and management, or even commercial applications, such as agricultural surveys or assessments. Additionally, the Idaho Power Company currently uses low-cost UAS to monitor fish populations on Idaho Rivers. Using aircraft to monitor wildlife is nothing new in areas with expansive wilderness and prohibitive terrain, but using small UAS to accomplish such tasks provides a dramatic reduction in the cost of airborne monitoring efforts. The Idaho Power Company reduced their costs considerably by selecting a small UAS solution over a manned helicopter proposal. As

commercial UAS are approved by the FAA, the opportunities to cut aviation costs by moving to unmanned systems cannot be stressed enough. The considerable forest, wildlife, and agricultural UAS application possibilities, as well as the notably open airspace available within the state of Idaho, provide a notable opportunity to companies looking at research, development, and testing of commercial environmental monitoring systems. Standing up a UAS test site or center of excellence would serve as an avenue to bolster advertising to attract business to the state.

UAS Industry Development Capability within Idaho

In addition to FAA UAS focal areas, Idaho has many ancillary areas that support UAS industry development. Boise State University maintains a program in material development that can contribute directly to the aerospace industry. The University of Idaho's College of Natural Resources, Agricultural and Life Sciences, and Engineering is currently working on sensor development, platform design, commercial applicability, and education outreach. Working with the National Science Foundation, the University has developed several hyperspectral camera systems that could be loaded on UAS to support applications such as broad area mapping or crop monitoring. The College of Western Idaho's Professional Technical Education programs are poised to feed graduates directly into UAS fields in wireless communications, software programming, electromechanical, sensors, CADD drafting, and machining. While not conducting direct technology research, CWI is uniquely posed to rapidly feed 4-year universities or businesses across the State and they have seen rapid student population growth in recent years.

Idaho's infrastructure is also primed to support UAS research, testing, and industry development. An Idaho Department of Aeronautics survey concluded the majority of Idaho's 126 public airports have beneficial climactic conditions to pursue both manned and unmanned aviation. Airspace within the state is abundant and not heavily used by commercial aviation, since there's no Class B airspace and only a single Class C terminal area. The Department also notes nearly all primary airports in Idaho have land available for expansion to further accommodate manned or unmanned aviation development efforts. An Idaho Department of Labor survey of companies that provide services which could be expanded, or modified, to meet the needs of a growing UAS industry shows suppliers cover a broad swath of business endeavors, ranging from machining to specialty paints to night vision equipment. These companies provide a solid foundation for further development of an aviation industry in Idaho, but the survey also provided a warning flag. Several companies were unwilling to participate in the survey, with an expressed goal to impede the expansion of unmanned aircraft into US airspace based, primarily, on privacy concerns. Due to the highly politicized nature of the UAS debate, it's critical to this endeavor for Idaho's governmental leaders to present a common voice for UAS policies to strongly advocate for personal privacy rights while also fostering and encouraging a new commercial UAS industry.

Conclusion

After reviewing the FAA SIR, Idaho appears very competitive for a UAS test site – with abundant land, a history of successful and ongoing UAS operations at INL, and accomplished and energetic state universities. This inventory also shows that, even if Idaho fails to win one of the six official FAA test sites, it still has considerable assets to contribute toward establishing a UAS center of excellence, developing a vibrant UAS technology sector, and attracting significant commercial interest and investment in the state.

Section 2
FAA UAS Test Site Selection Strategic Competitive Analysis ©

Steven C. Edgar, Advanced Aviation Solutions, LLC
Derek Wadsworth, Idaho National Laboratory

As directed by the Congressional Federal Aviation Administration (FAA) Modernization and Reform Act dated Feb 2012, the FAA is to select six Unmanned Aircraft Systems Test Sites to study the components necessary to integrate UAS into the National Airspace System (NAS). In preparation for writing a proposal for Idaho to be considered as an FAA UAS Test Site competitor, we made an effort to identify potential competitors and understand their strengths so we could distinguish our team from them and assess our competitive status. The stakes are high, current industry experts estimate this to become an $89B dollar industry in the next 15 years. Since we originally produced this document the FAA has issued the Screening Information Request (SIR) and we now know the requirements to be a competitor for one of the six test sites. It is interesting to know that even after the requirements were released, and we compared our previous assessment in light of the new information, nothing dramatically changed. The one surprise to all applicants was that the FAA specifically denied any applicant from teaming with a Federal Agency. This did create some difficulties for those UAS federally centric competitors who had teamed with agencies such as the Department of Defense, Department of Homeland Security and Customs and Border Patrol. While it created turmoil, those serious competitors will adjust accordingly.

OVERVIEW

There are a number of entities involved in UAS research and development. The level of involvement of these entities covers a broad spectrum. Some are academic institutions conducting rudimentary research and senior class project level efforts while on the other end of the spectrum are well-established programs with government, industry, and political support. This analysis attempts to capture efforts of established programs and rank those programs relative to test site designation probability. The assessment is made from information gathered from publicly obtained references and information provided by Advanced Aviation Solutions, LLC who is a partner in the Idaho UAS competitive effort. The analysis is subjective; however, having collected and reviewed all the information it does provide a basis of comparison. Many variables were considered when making the assessment. These variables include:

- Program maturity
- State and local political involvement
- Geography
- University connections

Essentially there are only a handful of viable competitors around the nation. These entities will be presented first. A quick review of the Continental US airspace reveals limitations to UAS flight test capabilities in the North East Corridor due to high civil

traffic volumes coupled with dense population averages, the same can be said for the SE coast and the SW coast. Yet the southern coasts offer maritime operations access. The Midwest is more desirable due to less dense populations and less congested airspace. Northern or southern Border States also have only "three" sides to operate from which can be a limitation. The military has many test sites in a wide cross section of States but they are not the primary focus of the FAA mandate. The FAA desires integration of UAS into the NAS and military installations are restricted airspace and not part of the public NAS. A quick analysis of where serious current UAS efforts have gained momentum shows New Mexico, North Dakota, Kansas and Oklahoma as serious competitors. These four players are primarily linked to military applications and military research; however, recently some have begun branching into civil UAS applications. Looking at the entire US identifies a "hole" in the Pacific NW of concentrated robust UAS Research and Development (R&D) except Idaho! Small efforts have started in OR, WA, MT and UT but none of these areas has any significant UAS presence; yet. This opens opportunity for the Idaho UAS contingent to fill this vacancy. We only need to market our in place assets and begin recruiting aerospace entities by showing them our strengths and associated capabilities to support them. The reference to national airspace is significant. Currently UAS flight operations, outside of military restricted areas must be contained within an FAA approved area of operation. These areas are identified and authorized by issuance of a Certificate of Authorization (COA). The COA is location and aerial platform specific and granted to only public entities i.e. state and local governments, state education entities, etc. All entities that have been issued a COA in the USA were identified and included as part of this analysis. The competition rules do not restrict an applicant to having an established COA, only that the applicant can qualify for a COA; those applicants with existing COA's will receive a higher point value in the scoring process associated with the UAS Test Site Selection (UASTSS). Idaho has an existing operational COA at the Idaho National Laboratory. This asset has been specifically approved for use in the UASTSS competition and has fully partnered with us in the effort. The FAA indicated that the private company or educational institution with oversight responsibilities for a Federally Funded Research Center (FFRDC) could be listed as a team member in competition. Battelle Energy Alliance (BAE) oversees the INL FFRDC and is our designated team member. It should be further clarified that the FAA stated that "the FFRDC infrastructure was authorized for unrestricted use by an applicant" under these conditions. Again, the Idaho UAS competitive team benefited greatly from this ruling/interpretation. In our professional opinion this is a very significant asset that will score the highest point value in this category.

ANALYSIS AND RANKING

The ranking of programs are divided into four tiers based upon a combination of programs, infrastructure, funds allocated, and political action/support. Programs within a given tier are ranked relative to one another.

TOP TIER

New Mexico

The top tiered competitor is New Mexico. New Mexico State University and its Physical Science Laboratory are international leaders in UAS regulatory and airspace issues. They have chaired the International Civil Aviation Organization (ICAO) UAS Study Group and are leaders in Communications, Navigation, Surveillance / Air Traffic Management efforts. In December 2012 they hosted DoD, FAA, DHS, NASA and many other Federal Agencies along with industry and academia in the UAS Technical Analysis and Applications Center (TAAC) conference covering all the major UAS topics of the day. Currently they are the ONLY FAA approved UAS Flight Test Center in the US National Airspace System. They have existing partnerships with the FAA, DoD, NASA, DOJ, DOE and DHS. They have access to the largest Flight Test Center airspace in the world; 15,000 square miles. Due to their advanced program and their already won "Test Center" title, they may not be a candidate for one of the 6 new UAS Test Site Designations.

The above assessment was left unchanged from prior to the FAA SIR release. A significant change occurred when the FAA indicated that the NM group would be unable to compete due to the fact that this group will be one of the ***judges*** for UASTSS applications! So our initial assessment that they would not be included was correct but for a different reason. This is to the benefit of all other competitors.

FIRST TIER

The First Tier consists of states and universities with programs, infrastructure and funding in place along with strong political action and support.

1. North Dakota

Recently, the State of ND put all other competitors on notice with this press release:

> ***Gov. Dalyrmple Recommends Funding to Land National UAS Test Site***
> ***Posted on 1/16/2013***
> *Gov. Jack Dalrymple today said North Dakota's open airspace and extensive aviation resources and expertise make the state a strong candidate for a national test site for unmanned aircraft systems (UAS). Dalrymple said the state must continue their work to land one of six national UAS test sites.*
> *"North Dakota has a long-standing history in UAS operations and development, ranging from military applications to offering the nation's first UAS bachelor's*

degree at the University of North Dakota," Dalrymple said. "By leveraging our resources and expertise at the University of North Dakota, the Grand Forks Air Force Base, the North Dakota Air National Guard and at our growing cluster of high-tech businesses that support our UAS industry, we have a great deal to offer in establishing a North Dakota test site."

The Federal Aviation Administration (FAA) Reauthorization bill requires the FAA to select six test sites as part of a program to safely integrate manned and unmanned aircraft in the National Airspace System. Initially, the FAA intended to identify the six test sites by the end of 2012, but the selection process has not been completed.

In his executive budget, Dalrymple included $1 million to support the North Dakota Airspace Integration Team's work in getting North Dakota selected as a national test site for UAS integration. Dalrymple's budget includes an additional $4 million in development funds to be appropriated only if North Dakota is selected to operate a national test site."

North Dakota has long been a leader in aviation education, and quickly expanded into UAS operations and development in the past 7 years. The North Dakota Congressional delegation, the Governor, the State Commerce Director and the University of North Dakota (UND) have mounted a considerable effort to enhance an already established position in the UAS industry. Their State leadership stood up the ND UAS Center of Excellence (COE) (self-proclamation by the Governor, not FAA assigned) and then promptly funded it in May 2006 with $2.5M and have received over $11.5M as of 30 June 2010. As of that date, over 24 Aerospace related companies have moved into the area. Simply put, this State has recognized the opportunity, took action and devoted much time, energy and resources in working towards winning one of the test site designations. Their political leadership capitalized upon this effort and was able to obtain US Air Force and Customs and Border Patrol UAS aircraft basing at nearby Grand Forks Air Force Base. With that effort completed they began to build their UAS Aerospace industry and improve their local economy. They have actively courted leading House and Senate members by hosting them at the ND UAS COE and UND and continually demonstrate their resolve and commitment to the UAS industry. They always rise to the challenge when any obstacle, such as the recently emphasized "privacy" issue, arose from the FAA as a cause for delay of issuing the FAA Screening Information request (SIR) for Test Site Competition. The UND and State leadership immediately established a committee and task force to address the concerns and the ethics of UAS employment within the boundaries of the USA. This immediate action mentality permeates their UAS efforts and they are aggressive about meeting the demands, whatever they may be, to ensure they are awarded this designation. The University of North Dakota in Grand Forks is widely known for its aviation program and in 2009 it established a Bachelor of Science in Unmanned Aircraft Systems Operation. As the pioneer in establishment of a specific UAS degree they have a jumpstart against the competition.

Kansas and Oklahoma are both strong in the analysis; some would rank OK above KS or as in this analysis KS above OK. Really it does not matter; they are both right behind North Dakota in their efforts and continually improving. It appears that their degree programs are stronger than UND's but their combined political leadership and resource commitment are behind ND.

2. Kansas

Congressman Jerry Moran has requested $3.5M from the federal government to fund Kansas State Salinas. Their UAS program at Kansas State University in Salina (KSU) is one of the first two Universities in the U.S. to offer a Bachelor of Science in Unmanned Aircraft Systems (UAS). They have a robust vehicle system with numerous different UAS aircraft platforms that are integrated into their curriculum. The KSU program approach is similar to the UND and Oklahoma models, but it is regionally specific and is not looking into market areas outside of DoD with any degree of concentrated efforts. They operate rotary and fixed wing UAS aircraft and specialize in the small UAS category (less than 55 lbs). Their airspace is a 15-minute drive from the campus and they operate hands on real equipment.

> *"Our program uses a hands-on approach for learning and attaining the skills needed to safely operate and manage UAS -- it's what sets K-State apart from the rest. K-State Salina's proximity to accessible restricted airspace creates an ideal setting for learning to fly unmanned aircraft. The Smoky Hills Weapons Range gives students the ability to gain hands-on flight experience. K-State Salina is also one of only a few universities with authorization to fly UAVs in the National Airspace System. The mission of the K-State at Salina Unmanned Aircraft Systems Program Office (UASPO) is to facilitate and promote the safe incorporation of Unmanned Aircraft Systems into the National Airspace System above Kansas and beyond. We use our experience operating, and maintaining aircraft to operate, within the National Airspace System to establish operational guidelines, policies, and procedures and provide for operator training for Unmanned Aerial Systems to fly within the state of Kansas. We also work closely with private contractors, government, and government-affiliated agencies to ensure the safe realization of the Kansas UAS concept of operations."*

Their fleet includes 12 vehicles. UAS growth and development for Kansas appears on track.

> **Tim Rogers (Executive Director Salina Municipal Airport) - Fri 04:31 PM 06/29/2012**
> *"For over five years the Salina Airport Authority, Kansas State University and the State of Kansas have actively supported the growth and development of the unmanned aerial systems industry in the state. UAS operations and training have become a significant component of student growth at the Kansas State University Salina campus. The K-State Salina UAS Program Office has partnered with the Kansas National Guard to make UAS aircraft and sensors available to emergency*

management incident commanders across the State during times of emergency response. This application of UAS technology and capability offers the citizens of Kansas an immediate return on the investment of the time and resources used to establish the K-State Salina UAS Program Office.

The K-State UAS Program Office has also established significant relationships with top tier UAS industry business partners. Through service agreements, K-State is able to offer a variety of research and development services to UAS companies that are developing new aircraft, engines, sensors and avionics. K-State's capabilities are enhanced by the fact that the UAS Program Office has access to nearby restricted air space and can also conduct UAS operations within Class D airspace at the Salina Airport.

The capabilities of the K-State Salina UAS Program Office make Kansas State University Salina a strong contender for designation as a Federal Aviation Administration UAS test site or an FAA Center of Excellence for UAS development. K-State has already taken significant steps to obtain both designations. K-State is working in partnership with other Kansas UAS operators and a significant number of other major university aviation programs to secure FAA designations as a test site and a center of excellence. K-State's success will result in significant economic benefits for our state. K-State's success will also add to the Kansas reputation as an aviation industry leader."

K-State has my full support and will gain the support of other local, state and national leaders.

Rounding out the resume of the K-State UAS program is their deployment in Greenland and Antarctica with UAS assets in support of R&D programs. A press release follows.

Kansas University UAV Development for Cryospheric Research Continues

After nine successful flights, three in Greenland and two in Antarctica, the Meridian Uncrewed Air Vehicle (UAV) has proven its airworthiness for radar-sounding in the Cryosphere. The Merdian has been developed over the past six years as the semi-autonomous flight vehicle of the Center for Remote Sensing of Ice Sheets (CReSIS) at the University of Kansas. With a range of approximately 1000 miles and an endurance of up to 12 hours, the UAV is poised to begin the task of augmenting crewed flights in the unforgiving Polar Regions.

The Aerospace Engineering team, lead by Associate Professor Rick Hale, first flew the Meridian in August 2009 at nearby Ft. Riley, and has since flown at Dugway Proving Grounds in Utah, Greenland and Antarctica.

In the summer of 2011 Greenland flights, the 1100-pound, 26-foot wingspan UAV flew 4 ice-penetrating radar antennas and returned its first radar images of the bedrock beneath central Greenland. While the chief goal is to acquire science data, the flights thus far have focused on establishing the airworthiness and reliability of the overall system. As such, the deployments have involved a team of

6, with duties ranging from piloting and aircraft maintenance to manning the two ground stations.

3. Oklahoma

Oklahoma State University has established both an Unmanned System MS and Ph.D. degree program embedded within their Mechanical and Aerospace Engineering program. The University Multispectral Laboratory operates several UAS related facilities including an adjacent runway/test facility. They have access to restricted airspace that they can fly UAS' within. The University of Oklahoma is also involved with and developed an unmanned helicopter as part of a $12M five-year project to create a port security system. The State leadership has developed a statewide collaborative effort to facilitate UAS integration into the NAS. Statewide entities collaborate on air vehicle design, payload operation and integration, sense and avoid technology research and development, flight-testing and evaluation, and education and training. These entities include state universities, state government, and private industry, and the collaboration includes agreements with federal entities to flight test unmanned technologies for purposes such as navigation flight checks, as well as multi-domain research tools facilitating UAS design and development through a comprehensive UAS engineering graduate (MS/PhD) degree program. An advisory council appointed by Oklahoma Governor Mary Fallin supports Oklahoma's collaborative UAS efforts at the state government level. A group of UAS scientists and engineers from academia, industry and state government teamed together to form USA-OK, or the Unmanned Systems Alliance Oklahoma, in 2008. The first summit was organized and held in February of 2009 in Guthrie, Oklahoma with an attendance exceeding 100. The 2009 Oklahoma Aerospace strategy report recommended that Oklahoma create a state chapter of the Association for Unmanned Vehicle Systems International (AUVSI). A core group of leaders begin the effort to create the bylaws, develop a proposal and obtain the necessary signatures to obtain state chapter status from AUVSI. With the enthusiastic support from the AUVSI board of directors, USA-OK was turned into an official AUVSI chapter in May 2011. In the summer of 2011, Oklahoma Governor Mary Fallin signed an executive order to create the Governor's Unmanned Aerial Systems Council. Members were selected from the UAS industry, state government, academia, and the defense industry and each was appointed by the Governor to serve in an advisory capacity. The council is chaired by Oklahoma's Science and Technology Secretary, Dr. Stephen McKeever. http://usa-ok.org/about-us

It should be noted that it might be a disadvantage to Kansas and Oklahoma due to the close proximity of these regions (geographically and politically) and their similar climatology, terrain and airspace characteristics. There is the real possibility that they will be asked to team together to form a single mid-west site.
The above statement still holds true yet one of the FAA criteria for selection is geographic and climatological diversity. Taken in that context these two locations are very similar. This could be a disadvantage to one of them. If they paired as a team it

would make them more viable in this context but we cannot verify if they have teamed together or are on another team or alone. It is a factor.

SECOND TIER

The Second Tier consists of sites that have programs and infrastructure in place, have funded programs but limited or fledgling political action and organization support for a consolidated effort.

4. Idaho

Since the first draft of this document the authors now believe Idaho is solidly in the First Tier. After spending over a month conducting an Idaho UAS "inventory of all things UAS in the state and accomplishing the FAA SIR application we are convinced we have a very competitive team and very strong UAS assets to put forth in the national competition. Of note is two pieces of legislation that passed this legislative session. Senate Bill 1184 a UAS privacy bill and Senate Concurrent Resolution 103, directing state agencies, educational and business entities to pursue winning one of the six UAS test sites. Both of these actions by our States political leadership show strong commitment to the development of the UAS industry within our boundaries. The Idaho Department of Commerce has also taken action to advertise its presence on the UAS national stage by purchasing a trade show booth at the Annual AUVSI symposium in Washington DC in August 2013. This is an internationally recognized "who's who" in unmanned aviation and many countries, states and large aerospace firms are in attendance over the three day event. Our neighbors in Utah have also purchased a booth. The above actions demonstrate resolve to build the industry, items which have added to our decision to move Idaho into the first tier category. The above added developments, coupled with our assessment of assets below, improve our competitive edge. The Idaho National Laboratory has built a nationally recognized unmanned aerial vehicle (UAV) program through innovative command and control work and successful integration of various sensor technologies. As such, the INL is home to the Department of Energy's Unmanned Aircraft Systems (UAS) Center of Excellence. INL has conducted UAS research for more than a decade. During this time a direct and indirect investment of more than $4M has trained and qualified personnel, constructed an UAS airfield, procured a significant inventory of fixed and rotary wing aircraft and established support facilities. In the middle of the 890 square miles of high plains desert that comprise the INL is a 1000' paved UAS runway. The FAA, through Certificates of Authorization, has approved the airspace over the INL for flights of ten different UAS platforms.

Since the release of the SIR, there is one other significant factor that has turned in our favor. The FAA requires a technical capability to obtain a "frequency spectrum" this capability is not easily obtained and the process is difficult to engage in. Our INL partner, BEA, has one in place and another team member has engaged in the application process and obtained the same authorization at another site in the US.

This is part of our applications resume and we will receive a higher point value due to this capability. Simply put, we have maximized our competitiveness in this category. The Idaho coalition leverages experience and expertise from each of its three leading universities. Idaho State University College of Technology is known for offering programs responsive to the needs of industry and provides education and training for a highly skilled workforce. The College has the ability and capacity to develop a solid Unmanned Aerial Systems program and can award certificates and/or associate degrees upon Idaho State Board of Education (SBOE) approval. An introductory course in Unmanned Aircraft Systems is being researched and developed for possible offering the fall semester of 2013. Current UAS projects include using micro-electromechanical system (MEMS) gyroscopes to monitor rotational forces in the aircraft. These forces could be caused from changes in inclination, rolling the aircraft, or rotational forces caused by differences in the propellers. Other research employs accelerometers to detect sudden changes in direction or velocity; coupled with Global Positioning Sensors (GPS), the location, speed, and direction of the aircraft can be determined. Recent research is investigating the use of ultrasonic and infrared ranging sensors to detect other objects in the vicinity of the aircraft, and when in range, determine the distance of the aircraft to those objects. Far more areas of UAS application are contained within the Idaho UAS inventory document produce by the Idaho Department of Commerce. The Idaho Department of Commerce is forming a new UAS working group, as authorized by our Governor, for UAS industry Development in Idaho. The purpose of the group is to position Idaho to respond to the needs of UAS operations and test and development in Idaho. Entities forming the commission include Idaho Department of Commerce, Idaho Department of Transportation, Boise State University, Idaho State University, College of Western Idaho, University of Idaho, North Idaho College, Idaho National Laboratory, and many local private businesses, Empire Airlines and Advanced Aviation Solutions, LLC. The inaugural Idaho UAS Working Group meeting was held in Boise during December 2012. We anticipate another meeting with many more attending in late Spring 2013.

5. Ohio

Ohio has recently entered the UAS Test Site Competition via press release from their Governor's office. (See below selected excerpts) The press release is their first of its kind and it spells out future plans and goals. It is our opinion that the state has limited experience with UAS test and operations but they undoubtedly will attempt to pull together a coalition and a plan for application for one of the test sites. They have indicated they will fund the efforts with $1.5M seed money from the State of Ohio. This funding has not yet come to fruition. They are sponsoring a UAS conference in April 2013, hosted by Sinclair Community College, a school that is now offering a standalone "Short Term Technical Certificate" in UAS, which is very limited in scope. Sinclair Community College, located in Dayton, has a strong strategic partnering with Wright Patterson Air Force Base and University of North Dakota. SCC focuses on certificate programs in UAS rather than longer-term degree programs and they partner with UND for more advanced educational opportunities. Overall, the state is trying to

enter the fray but we assess their infrastructure to be in development versus well established. As an example, the airspace they reference for UAS test, a former Military Operating Area (MOA), is not currently approved for UAS test operation. Additionally, this press release indicates, that the MOA does not have an underlying airfield, which means they must transit civil airspace to get to and from their proposed operating airfields. This is a very large obstacle to overcome. The FAA criteria specifically state that the test organization is responsible for safe separation of UAS vehicles from all other traffic while in transit.

August 8, 2012 OHIO LAUNCHES ONE-STOP-SHOP FOR UNMANNED AIRCRAFT EFFORTS

Will Partner with Indiana in Pursuit of One of Six FAA Test Site

LAS VEGAS–Today at the Association for Unmanned Vehicle Systems International annual conference, the State of Ohio announced that it is creating the Ohio Unmanned Aircraft Systems Center and Test Complex to serve as a single-point resource for government, industry, and universities seeking to conduct research, train personnel, and develop the technologies and procedures to safely integrate unmanned aircraft systems (UAS) into the National Airspace System. The Center will facilitate the industry's efforts by leveraging Ohio's significant, existing UAS-ready resources, including a flight test range, airfields and a full complement of modeling, data analysis, research centers and engineering services. Ohio also announced a partnership with Indiana to pursue designation by the Federal Aviation Administration (FAA) as one of six UAS test sites. "The Ohio UAS Center will be a problem-solver and door-opener for anyone who needs airspace, access to ground facilities, research and analytic support and everything else it takes to move the UAS frontier forward safely, successfully and steadily. Ohio possesses the world's oldest continuously-operating aviation and aeronautics development infrastructure, which not only brings with it substantial technological know- how, but also a culture that thrives on innovation and knows how to support and cultivate it. With that experience comes an appreciation for the safety and security required to properly run this operation—something most other locations simply can't duplicate. All of this comes together to create enormous economic development and job creation potential for Ohio, which is very exciting," said James A. Leftwich, the State of Ohio's special advisor for UAS initiatives.

An Aggressive Pursuit of the Future of Aviation: Explosive growth is predicted for the UAS industry in the next 10 years. According to a recent study by the Teal Group, annual worldwide spending on remotely piloted aerial systems will almost double over the next decade from $6.6 billion to $11.4 billion, totaling $90 billion in the next 10 years. Ohio is well-positioned to compete for the industry given the strength of its aeronautics industry, with an emphasis on research and training, as well as its existing infrastructure of airspace and facilities. A New Mission for Existing Airspace: The UAS Center's primary airspace will include a largely rural area east of Cincinnati and south of Columbus, including airspace previously restricted for Wright-Patterson's 4950th Test Wing, which was

disbanded in 1994. This airspace is now managed as a "military operating area" by the Springfield Air National Guard Base. Since it is already used for military missions, residents and aircraft traffic in the area will see little or no change. The range will take advantage of the nearby Springfield-Beckley Municipal Airport and Wilmington Air Park to support its operations. Natural Tie-In with Wright-Patterson: The UAS Center's proximity to Wright-Patterson will provide the base with new unmanned system test capabilities. Wright-Patterson is home to the Air Force Research Laboratory, which leads Air Force efforts to research and test technologies to safely integrate unmanned systems into the National Airspace System. Wright-Patterson also is responsible for designing and buying new aircraft for the Air Force. Partnership with Indiana for Coveted FAA Site: Ohio Governor John R. Kasich and Indiana Governor Mitch Daniels have agreed to jointly seek designation by the FAA as one of six test range sites under a five-year program created by Congress to accelerate the safe integration of unmanned aircraft systems in the National Airspace System. The range proposed to the FAA will also include airspace used by Camp Atterbury, a training base of the Indiana National Guard near Edinburgh, Indiana, as well as other nearby infrastructure. The FAA is expected to make its selection in December. The estimated $1.5 million start-up costs will be paid by the State of Ohio, with the Center eventually becoming self-funded through user fees. Sites in the Miami Valley are currently being explored to house the Center's offices. The Dayton Development Coalition, a nonprofit economic development organization that promotes job creation in the 14-county Dayton region was charged by the State with leading planning for the UAS Center."

THIRD TIER

Third Tier sites have limited to no UAS infrastructure, no funding and limited to no political effort/action/support. They may have research projects that employ UAS but have not, as of this writing, formed a plan for contention for one of the six test site designations. It is now postulated that Oregon has partnered with Alaska as team members in the UASTSS competition. In our assessment this brings a tremendous number of complex logistical and business issues to the joint application due to the geographical separation. Unlike the paring of Ohio and Indiana, these two teammates have a greater obstacle to overcome. It is also difficult to assess how the FAA will view this vast geographically separate team.

6. OREGON

The Economic Development for Central Oregon, (EDCO), has established a web site promoting their efforts. Senator Sen. Ron Wyden backs this opportunity for Central Oregon and delivered a pitch on the US Senate floor; however, the state has not aggressively pursued options beyond what is stated here and in their press release below. Additionally, EDCO has gathered support from both public and private entities, Central Oregon's congressional delegation, the Oregon legislature, Governor Kitzhaber, and cities and counties to establish one or more test sites in the region.

This support is only verbal to this point and no other public efforts have been observed since May 2012. Oregon faces similar airspace designation challenges as previously cited in our assessment of Ohio. While public support expressed by political officials is noteworthy, the efforts appear to have stalled out.
Update: as of March 2013, we now know their efforts have been reinvigorated yet they face serious obstacles to win a site on their own. Thus, the suspected partnering with the University of Alaska and the State of Alaska.

Central Oregon Vying for UAS test site
May 16, 2012
"In an April 2012 news story, Bloomberg News reported that the UAS (Unmanned Air Space) industry in the United States is valued at $5.9B with an estimated increase to $11.3B by 2021 – less than 10 years away. With this rapid development the need for UAS use in civil operations and competition in UAS manufacture and operations from other countries such as Israel, it is imperative that the FAA immediately set standards to integrate UAS into the national airspace, as well as designate national test sites to facilitate the process. There are to be 6 sites designated in the next year. Oregon State University (the Champions to the project) recommends the FAA consider the strengths of Central Oregon/Northwest as a test site. Central Oregon has a large area of restricted air space with low traffic of which could be utilized as test space. Areas include the Juniper MOA and space up on the Warm Springs reservation, with the Madras Airport just south. Central Oregon offers a very diverse geography, consistent climate, substantiated infrastructure and desirable lifestyle. OSU Cascades and Central Oregon Community College are offering classes specific to Unmanned Vehicle Systems making it apparent that Central Oregon/Northwest should be chosen to be one of the test sites."

That same month in 2011 the Oregon House passed a joint memorial urging the feds to allow UAS testing in Central Oregon.

Wednesday, May 4, 2011
Oregon House Approves Measure Endorsing Remote Testing Area
Oregon House Approves Measure Endorsing Remote Testing Area - The Oregon House of Representatives has approved a memorial urging the federal government to permit the testing of unmanned aircraft in remote Central Oregon. Rep. Jason Conger (R-Bend) introduced House Joint Memorial 20, saying the designation would attract aerospace, aviation, and manufacturing industries to the area, and would create thousands of well-paying jobs in the process. "We have an opportunity to become a leader in drone research and development," Rep. Conger said in a recent press release. "Central Oregon offers a highly-skilled workforce and vast stretches of remote land that's ideally suited to unmanned aircraft testing. I introduced House Joint Memorial 20 to send a message to Congress that Central Oregon welcomes these important industries and the jobs they will provide." HJM 20 urges Congress to enact legislation requiring the Federal Aviation

Administration to expedite the approval process for unmanned aircraft testing in rural counties with an unemployment rate of 10 percent of higher. "Economic Development for Central Oregon has worked hard to bring unmanned aircraft testing to Central Oregon," Conger said. "Drone technology is a new and growing segment of the aviation industry, and represents a real opportunity to diversify our economy and create new jobs in Central Oregon."

Wednesday, August 3, 2011
OSU and EDCO Announce Partnership to Test Unmanned Aerial Systems (UAS)

Bend, OR - Economic Development for Central Oregon (EDCO) and Oregon State University (OSU) have signed an agreement to develop technologies related to unmanned aerial systems that will benefit OSU's academic and research programs, particularly natural resource management. Simultaneously, the agreement would help EDCO incubate new UAS startups and bring additional UAS businesses to the region and to Oregon. EDCO conservatively estimates the potential economic impact of recruiting UAS companies to the region to be approximately 450 employees, $28 million in payroll, and an overall economic impact of nearly $75 million within a seven-year period.

"To diversify Central Oregon's economy, we systematically review all the industries EDCO targets," noted Roger Lee, executive director of EDCO. "We've now identified the growth segment in aviation—the UAS sector—that capitalizes on our region's natural and human resources. We see UAS, and other technology initiatives, as key steps in growing jobs and economic activity in the tri-county area and beyond."

"The signing of this MOU," Lee added "is an important step in attracting UAS testing activities. In turn, that groundwork will attract industry to either relocate or start up in Central Oregon."

The initial goal of the partnership is to establish one or more specific projects in which OSU researchers can conduct remote-sensing and engineering experiments, and EDCO can create an initial series of UAS test flights for those experiments. Through special licenses called Certificates of Authorization (COAs), the Federal Aviation Administration (FAA) authorizes test flights. As a public partner, OSU benefits from the partnership by creating a test infrastructure to advance technologies such as robotics and sensor development and deploy them in ways beneficial to a number of OSU academic programs, including engineering, forestry, agriculture and other earth sciences.

"For OSU, the ability to test in our backyard is exciting," said Rick Spinrad, vice president for Research at OSU. Current testing for the university that measures snowpack from the air is taking place in Colorado, for example. "It could be quite beneficial and efficient to conduct these tests over the Cascades, closer to university resources, receiving real time data and working with Oregon companies," he said. Spinrad oversees OSU's substantial research efforts, which last year translated to over $260M in support.

Last year, EDCO's aviation recruitment committee developed strategic goals to establish Central Oregon as an R&D center for UAS research and as an incubator for UAS businesses operating in the Northwest. An important component of the plan, required by the FAA, is a public partner to initiate testing.

"With this agreement with Oregon State University," said Collins Hemingway, volunteer chair of EDCO's Aviation Recruitment Committee, "our initiative gains major ground in its goal to establish a UAS industry in Central Oregon."

According to numerous studies, the current UAS market is $5 billion and is projected to grow annually by 10 percent. Applications of particular benefit to the Northwest include firefighting, search and rescue, rural law enforcement, infrastructure monitoring, low-impact inventory of plant and wildlife populations, and overall resource and land management.

Currently, UAS companies face long delays in securing air space to test new technologies, which include airframes, controls, sensor packages and software. Few places in the country meet the safety protocols required for testing by the FAA. Delays of six months or more for only a few days of testing are common for some smaller UAS firms.

Because Central Oregon has large expanses of airspace that are over lightly populated rural areas and away from major airports and air traffic corridors, and because the region has a history of developing and testing experimental manned aircraft, the region believes it can obtain approval for the testing of experimental unmanned systems while meeting the FAA's strict safety protocols.

Under the EDCO-OSU partnership, the initial series of test flights will use the COA method, but the hope is that the FAA will designate Central Oregon as one of six permanent testing areas in the nation. The proposal to create six new permanent sites is currently before Congress.

EDCO has gathered support from both public and private entities, Central Oregon's congressional delegation, the Oregon legislature, Governor Kitzhaber, and cities and counties to establish one or more test sites in the region.

"We are all working together to make UAS testing a reality in Central Oregon," said Collins Hemingway. "The sooner we start, the sooner we attract high-quality companies and start adding well-paying jobs."

The Oregon team lacks actual experience in UAV operation and UAS resources; however, they are pursuing teaming with Boeing Insitu (manufacturer of the Scan Eagle). This teaming relationship would bring credibility to the Oregon team and raise their ranking in this analysis. Another wildcard for this team is the University of Alaska Fairbanks (UAF). Oregon has actively sought UAF involvement. UAF has extensive experience operating UAVS in cold weather test conditions and they enjoy vast expanse, low-density population and somewhat low airspace congestion even though there are many private planes in use. If Oregon teamed with UAF, although the airspace would not be contiguous, it would again raise their rankings in this analysis. There is no indication that UAF is mounting an effort to secure a test site on their own.

7. Montana

In late 2010, State Sen. Ryan Zinke began a project to bring UAS to Montana for testing and research. He is a former Navy SEAL commander who is aware of the benefits of this technology and sees the civilian applications in his state. He urged the following schools to establish a "UAS Center of Excellence": MSU, Rocky Mountain College, and Mississippi State. No other action has been publicized from his office on the topic. Montana's senior Senator, Max Baucus, in early 2011 followed Zinke's lead and amended the FAA reauthorization bill, along with Senator John Tester (MT), to expand the number of FAA UAS Test Sites. He argued that Montana is the perfect location for a test site. Rocky Mountain College (Billings), MSU (Bozeman and Northern campuses) and Mississippi State University have formed a consortium to study challenges related to unmanned integration into national airspace. The significance here is that their leadership is beginning to see the opportunity.

8. Utah

The Utah Governor's Office of Economic Development attended the most recent AUVSI trade show in Las Vegas in August of 2012 and presented materials advertising *"Our unique setting…hundreds of square miles and 58,000 feet of elevation for testing."* Utah State University has begun using UAS aircraft in their water research program. "*The AggieAir Flying Circus is a service center at the The Utah Water Research Laboratory (UWRL) is a stand-alone facility located at Utah State University (USU) on the Logan River, Logan, Utah. The UWRL operates within an academic environment and collaborates with government and private sectors to address technical and societal aspects of water-related issues, including quality, quantity, distribution, and conjunctive use. This is accomplished through providing more than 100,000 square feet of state-of-the-art laboratory, computer, and office space. .Utah Water Research Laboratory which provides high resolution, multispectral aerial imagery using a small, unmanned aerial system called AggieAir. Because AggieAir is a low-cost, easy-to-use platform it is able to map small areas quicker, more frequently, at finer resolution, and at a smaller cost than conventional remote sensing platforms (satellite and manned aircraft). Furthermore, AggieAir is independent of a runway, which gives the user the ability to launch the aircraft from virtually anywhere. Some applications for AggieAir include monitoring of soil moisture and evapotranspiration in irrigated agriculture, riparian habitat mapping, surveying construction projects, wetland mapping and monitoring, fish and wildlife tracking, etc.*" While this effort is on track, it is limited in scope and their access to testing range airspace and operating airfields has yet to be fully developed. Utah does have an AUVSI chapter and is marketing their State as a UAS "friendly" location to relocate to.

9. Washington

The state of Washington accomplished a moderate study, "***The Use of Small Unmanned Aircraft by the Washington State Department of Transportation"*** The study was accomplished in 2008 and ended with mixed results due to failure of equipment, operator errors and weather challenges. This study was conducted in cooperation with the University of Washington and the US Department of Transportation.

Abstract

Small, unmanned aerial vehicles (UAVs) are increasingly affordable, easy to transport and launch, and can be equipped with cameras that provide information usable for transportation agencies. The Washington State Department of Transportation conducted a series of UAV tests to evaluate their capabilities while also exploring institutional issues. These tests, while exploring the general capabilities of UAVs, focused on evaluating the use of a UAV as an avalanche control tool on mountain slopes above state highways. WSDOT's maintenance division has an active snow avalanche control program that is designed to reduce highway closure time and hazards to motorists, and the use of UAVs was seen as having some potential operational advantages. The UAVs also captured aerial images suitable for traffic surveillance and data collection. The evaluation found that the main limitation to UAV use is institutional, particularly the need to obtain approval to fly from the Federal Aviation Administration (FAA). This approval process will make UAV use a challenge, but these issues may change as the FAA considers new rules.

Ultimately the effort went no further without public explanation. Obviously Boeing Aircraft Company has a business in UAS development and is working closely with DoD and other governmental agencies but has not fully developed their potential in the unmanned arena. This will not be the case for very long and we expect they will become main innovators in the technology. I have not uncovered any other public efforts in WA.

10. NEW JERSEY

The state of New Jersey commissioned a **"Study for the Advancement of Unmanned Aircraft Systems in Southern New Jersey"** in 2010 and to date no real significant action has been taken on that private study recommendation. Obviously, Super Storm Sandy has rightfully occupied that states leadership's attention.

ADDITIONAL NON-RANKED ENTITIES

For completeness the following entities were reviewed as well. They were selected based on the fact that they, at one point, had an active Certificate of Authorization with the FAA. One indication of a Public (i.e. government) sponsored group's strength in the Unmanned Aerial Systems (UAS) arena is whether they have been granted a COA. In order to receive a COA, a minimum standard of competency must be demonstrated. A

review of a list of COAs granted by the FAA as of April 2012, reveals the involvement of a number of universities (public entities) in the UAS field. The following presents the engaged universities, their COA status, and a brief assessment of their capabilities.

Cornell University
COA Status: Expired
Cornell University sponsored a group of undergraduate engineering students to design, construct test and eventually fly an autonomous fixed wing aircraft in AUVSI's International Student Unmanned Aerial Vehicle Competition. It appears that no current activity is being conducted.

Eastern Gateway Community College
COA Status: Active
Eastern Gateway Community College received a one-year COA to fly a UAV for professional training purposes. The intent was to establish a training program for qualified emergency management, law enforcement, and other public safety personnel. There is no indication that this effort really ever got off the ground.

Georgia Tech Research Institute
COA Status: Active
Georgia Tech has very good capabilities general capabilities in unmanned vehicle autonomy. In the past they have flown roto-craft and demonstrated some autonomous behaviors. Their UAV experience is limited and focused on basic research. It does not appear that they are interested in the test site designation.

Middle Tennessee State University
COA Status: Active
An educational collaboration between the U.S. Army, the U.S. Marine Corps and MTSU has been established. The intent is to research ways to augment small robots with affordable hardware and software that allows a Raven unmanned aircraft to be deployed as an eye-in-the-sky relay, thereby ensuring the synchronous operation of land robots with unmanned vehicles in the air. This is not an extensive UAV effort it is more of a multi-system interaction and control effort.

Mississippi State University
COA Status: Active
Mississippi State students have built and flown UAVs as part of AUVSI competitions. In May of 2012 Mississippi State sponsored an Unmanned Aerial Systems Symposium. This was sponsored in conjunction with the local AUVSI chapter. The university's program is really centered on senior capstone projects and no real UAS research and development is being conducted.

New Mexico Tech
COA Status: Active
New Mexico Tech is a collaborator with New Mexico State University

Nicholls State University
COA Status: Expired
Not much information was available. It does not appear that any research is ongoing.

Texas A&M University Corpus Christi
COA Status: Active
The university has a small R&D program developing the ability to combine UAV acquired sensor data to detect oil spills and other pollutants on water surfaces. Their COA encompasses approximately 500 sq. miles of coastal land and water. The College of Science and Engineering has established an Unmanned Aircraft Systems Initiative. It appears that they have either teamed with or hired American Aerospace Advisors Inc. (AAAI) who has conducted test flights for the university during January 2013. In the coming months AAAI will train six University personnel in various aspects of the aircraft's operations, including ground-crew activities and the roles of mission commander and observer. The training exercises and scientific missions will make use of a multi-spectral payload of high-definition video, infrared and ultraviolet cameras. An on-board computer system will capture image data from the three cameras simultaneously and tag the location of each image using global positioning system (GPS) data.

Texas A&M-Corpus Christi is leading a statewide effort to persuade the Federal Aviation Administration (FAA) to designate Texas as a test range for technologies that will allow large and small unmanned aircraft to operate safely in the national air space.

Dr. Luis Cifuentes, University Vice President for Research, Commercialization and Outreach, said research was but one piece of a complex effort.

"We call it the Lone Star UAS Initiative," Cifuentes said. "We're not the only state in this hunt. There are at least 40 others. To be competitive, we will need all of the pieces working together – industrial, military, research, governmental and political."
This could be an up and comer for the competition; however at this point they do not have an organized team vying for the designation. They deserve a serious look.

Texas A&M University Texas Engineering Experiment Station
COA Status: Active
The Texas Engineering Experiment Station (TEES) is conducting a limited amount of unmanned underwater vehicle research; however no evidence was found that they are involved in UAS. They do have a satellite campus at the New Mexico State University and this may be the UAS connection. If they are collaborating with NMSU, then their competitive analysis is covered with that of NMSU.

Texas State University
COA Status: Active
Texas State University has a small UAV developed by Utah State University. They are using it to collect high-resolution multispectral digital aerial imagery. They are targeting applications including management of invasive plant species, mapping riparian and river habitats, bank erosion, and precision agriculture. The program is in support of their

Meadows Center for Water and the Environment. There is no evidence that they are interested in a test site designation.

University of Alaska Fairbanks
COA Status: Active
Legitimate Contender

University of Colorado
COA Status: Active
Conducting research and development for both unmanned ground and air systems. This research is coordinated through the Research and Engineering Center for Unmanned Vehicles. Research in UAS includes small UAS design, ad-hoc communication networks, and cooperative UAS teams. They are also involved with Brigham Young University in a National Science Foundation (NSF) funded Center for Unmanned Aircraft Systems. The industry/University Cooperative Research Center for Unmanned Aircraft Systems (C-UAS) has been established to address the issues common to the UAS industry that limit widespread application across military, civil, and commercial domains. The center solicits membership and requires annual dues. Membership gives potential access to NSF grant money funneled through the Center and also gives a voice relative to the organization's research agenda. It does not appear that this is a significant contender; however they are well organized and have a federally funded UAS R&D program. Need to keep an eye on them. The Center may be an entity that could bring strength to our proposal if we decide to reach out to the intermountain west region.

University of Connecticut
COA Status: Active
A professor in the School of Engineering's department of Mechanical Engineering has a COA from the Federal Aviation Administration to operate a small battery-powered helicopter as part of his academic research. No flights have yet taken place since the project has apparently yet to be funded. The objective is to research autonomous navigation and guidance systems. No interest in being part of a test site.

University of Florida
COA Status: Active
The University of Florida is teaming with a commercial entity to develop a small-unmanned aircraft system (SUAS) that is both affordable and user-friendly for natural resource assessments and monitoring. The system would offer rapid deployment, simplified transportation to remote locations that lack runways, and reduced logistical burdens. The commercial entity provides the UAS expertise and lays the groundwork for COA application and management. The University Florida and Florida Fish and Wildlife conduct the research and data analysis. This appears to be a university research program with no inclination to compete for a test site.

University of Michigan
COA Status: Expired
The University of Michigan is the sponsor of the Michigan Unmanned Aerial System Center (MI-UASC). The mission of the MI-UASC is "to gather scholars, scientists, operators, experts and industry leaders to foster the growth of the industry and organize a fast-growing center of expertise and operations. To be recognized as one of the six centers of excellence within the next two years. Develop an innovative and dynamic center for which the headquarters and main activities will be located at Alpena County Regional Airport."

The web site claims that "*MI-UASC is led by a board of directors formed of private companies and industry leaders, major Universities and Colleges from across the Country, government agencies, Michigan National Guard and Alpena Airport and County leaders. The committee presently meets on a weekly basis to support start-up activities.*

The MI-UASC steering committee mission is entering its second phase. Started in August of 2012, actions have been taken to ensure Michigan UAS proposition is well advocated through the country. Participants in the MI-UASC have a nation-wide advocacy agenda to promote the MI-UASC candidacy to be one of the six UAS test site designated by the FAA. Dedicated working groups led by professionals are working aggressively on the MI-UASC initiative."

Further research should be conducted to determine the legitimacy of this group. Given the fact that the COA is expired it does not appear that they are a real threat. It appears that there is a lot of window dressing with no real capabilities or resources. This effort seems very similar to the Oregon State led team.

University of Wisconsin
COA Status: Expired
It appears that the University of Wisconsin's real interest in UAVs is using them to deploy instruments in hurricanes. They do not fly their own UAVs but rather they attached their instruments to a NASA Global Hawk specifically used for hurricane research.

Utah State University
COA Status: Active
Utah State has developed a small, remote sensing platform called AggieAir to collect high resolution, multispectral aerial imagery. Because AggieAir is a low-cost, easy-to-use platform it is able to map small areas quicker, more frequently, at finer resolution, and at a smaller cost than conventional remote sensing platforms (satellite and manned aircraft). Furthermore, AggieAir is independent of a runway, which gives the user the ability to launch the aircraft from virtually anywhere. Some applications for AggieAir include monitoring of soil moisture and evapotranspiration in irrigated agriculture, riparian habitat mapping, surveying construction projects, wetland mapping and monitoring, fish and wildlife tracking, etc. USU offers many services around AggieAir (aerial imagery, image processing, AggieAir training, etc.) through its service center. In addition, the

AggieAir platform can also be purchased through USU. It appears they are in the market to provide a service rather than compete for a test site.

Virginia Commonwealth University

COA Status: Expired

Virginia Commonwealth University has a few research projects related to UAS control. These are more student research projects rather than a UAS program sponsored through the university.

Virginia Polytechnic Institute and State University

COA Status: Active

It appears that the COA was established so that a team of students could build and fly a UAV in an AUVSI competition. There is no evidence that there is any further UAV efforts being conducted.

CONCLUSION

One item to consider within this assessment is the fact that Idaho has more to offer than everyone on this list except New Mexico and North Dakota. An Idaho UAS inventory and capabilities has been presented in this analysis. The inventory shows what capabilities we have and the infrastructure in place from which we can capitalize. Along with the inventory, a press release is being staged from our State leadership announcing our intention to enter the national stage. This will be closely coordinated with our entire state delegation so that they will immediately unleash a full on effort in Washington DC. This coordinated effort will involve the entire Congressional delegation taking our case to the FAA administrator, the Department of Transportation and the UAS Caucus's that exist in the House and the Senate, placing all of them on notice that Idaho is a superior choice for UAS Test Site Selection.

Section 3
Idaho UAS Inventory
Contributor Submissions
See Attachment 1

Contributor submissions published as provided to Advanced Aviation Solutions, LLC

Idaho State University
Unmanned Aircraft Systems Inventory

Prepared by Office for Research & Economic Development
January 18, 2013

Idaho State University has significant expertise and capabilities in the area of unmanned aircraft systems. They span several different colleges within the University and include:

College of Technology:

The College of Technology provides quality education and training for future technicians in trade and technical fields associated with aviation electronics, sensors, and instrumentation aligned with unmanned aerial vehicles (UAVs). The technology in programs such as Aircraft Maintenance Technology, Robotics and Communication Systems Engineering Technology, Computer Aided Design Drafting, Computerized Machining, and Geomatics Technology have direct applications and offer courses that can be tailored to the avionics industry. Other programs such as Emergency Management, Fire Service Administration, and Law Enforcement could also offer auxiliary courses related to the field.

The ISU College of Technology has experienced a five year increase in enrollment of 25.61 percent in professional technical programs (Idaho Division of Professional Technical Education, Fiscal Year Enrollment History Report). In the last five years, enrollment in the Robotics program has grown from 47 students to 89 students, an 89.4 percent increase. The Aircraft Maintenance program has increased enrollment from 19 students to 42 students, a 121 percent increase. Program enrollment in these and many other programs at the College of Technology is healthy and continues to lead to graduates prepared for high-tech, high-demand fields.

Graduates from many of the College of Technology programs are highly sought after because of the quality and rigor of curriculum and instruction. The Robotics program graduates consistently gain employment in companies with direct links to military UAV production. Current College of Technology graduates in these high-tech fields are starting entry-level jobs at salaries ranging from $22 to $41 per hour.

The Workforce Training unit in the College of Technology provides short-term, high-tech training and industry upgrade for current workers and community members. Courses can be constructed on demand to deliver non-credit educational opportunities provided by experts in the industry.

The ISU College of Technology is known for offering programs responsive to the needs of industry and provides education and training for a highly skilled workforce. The College has the ability and capacity to develop a solid Unmanned Aerial Systems program and can award certificates and/or associate degrees upon Idaho State Board of Education (SBOE) approval. Following are some specifics from current College of Technology programs directly related to UAS.

Robotics and Communication Systems Engineering Technology (RCET)

During their three years in the RCET program, students are trained in the types of sensor, communication, electromechanical, circuitry, and software systems that are found in UAS vehicles. Past and present student projects have included UAS vehicles. Here is a closer look at what they learn.

Sensors

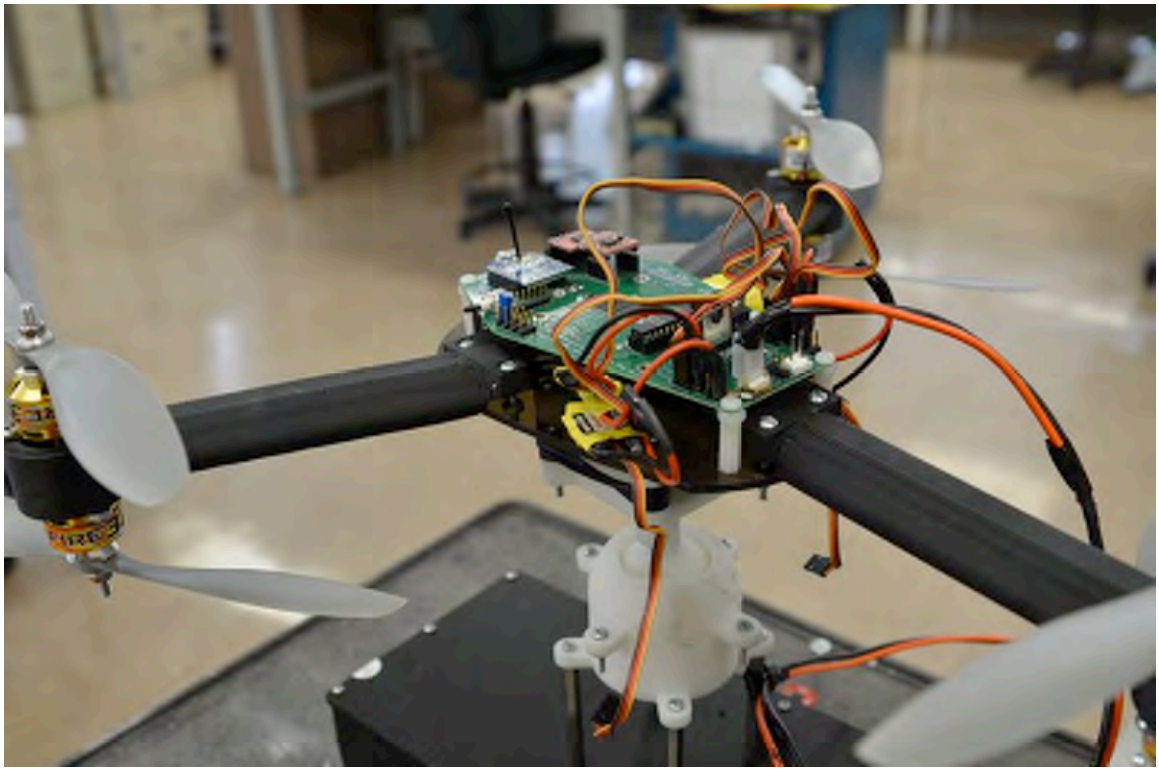
In current UAV projects, students use micro-electromechanical system (MEMS) gyroscopes to monitor any rotational forces in the aircraft. These forces could be caused from changes in inclination, rolling the aircraft, or rotational forces caused by differences in the propellers. Students use accelerometers to detect sudden changes in direction or velocity. Global positioning sensors (GPS) are used to determine the location, speed, and direction of the aircraft. Because the GPS sensors only give the direction of a moving device, and the direction of the aircraft can be altered by wind, students utilize an electronic compass to determine the orientation and heading of the aircraft. Ultrasonic and infrared ranging sensors are used to detect other objects in the vicinity of the aircraft, and when in range, determine the distance of the aircraft to the ground. Students have recently started to work with detecting the back electromotive force (EMF) produced by the electronic motors to monitor the motors speed and efficiency. They are also beginning to use video cameras with object recognition software to track specific objects by movement, shape, or color.

Current UAV Student Project Nearing Readiness for Flight Testing

Communications

Students investigate a wide variety of wireless communications techniques for interfacing the UAVs with the ground control station. 2.4 GHz, and 900 MHz spread spectrum radios are predominately used to handle the primary communications link. Video information is sent separately with some encoded telemetry data, on a variety of frequencies. Both analog and digital transmitters are currently being used.

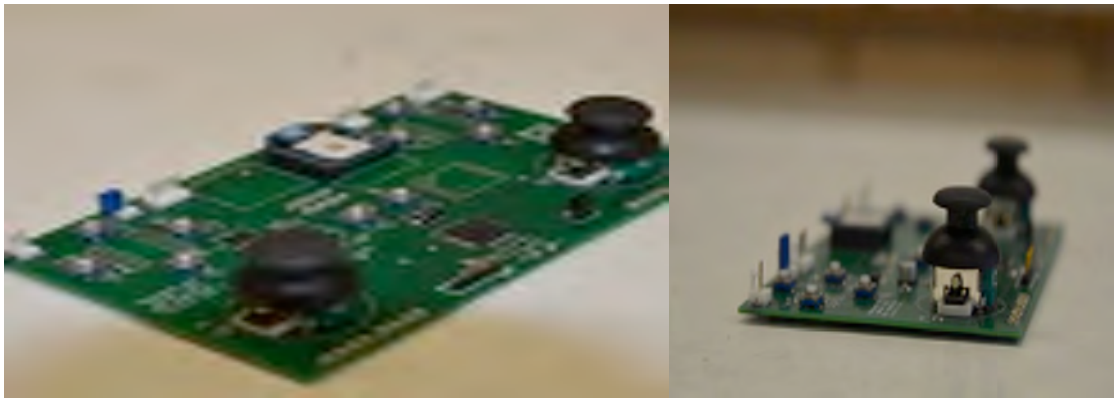
The onboard system and control station communicate through an asynchronous serial link utilizing the spread spectrum radios. Many of the onboard systems require the use of multiple microprocessors. I2C, SPI, and MSSP protocols are predominantly used to interface the primary microprocessor with any other required microprocessors.



Current UAV Student Project at Idaho State University

Electromechanical

Students learn a variety of motor types used to control mechanical systems on the UAVs. Three phase brushless DC motors are used for main propulsion systems. Single phase DC and servo motors are used to control elevators, flaps, rudders, cameras, and landing gear.



Examples of student built circuits for UAV flight control.

Circuitry

The printed circuit boards, interfacing hardware, and motor controls used in the UAVs and the ground control station are student designed and built. Components used in the

system are chosen by the student as needed to interface with given sensors or motors. Circuits must be designed to conform to size and weight restrictions needed for each UAV.

Software

Microprocessor firmware is completed by students using either assembly level or embedded C programming as required by the individual microprocessor used. Ground control systems utilize Visual Basic, Lab View, C, and Python to create the graphical user interfaces (GUI) for the operator interface and data gathering systems.

Computer Aided Design Drafting (CADD)

CADD students learn to visualize ideas, take them through the design and 3D modeling phase, create working drawings of complex parts, and use rapid prototyping technologies to create 3D ABS plastic models of complex designs. The design of UAS aircraft will likely be done using 3D modeling and prototyping techniques.

Geomatics Technology (GEMT)

GEMT students learn how to use precision GPS systems to locate points to within 1/8" of accuracy. This technology may have applications in the guidance of UAS systems and/or to pinpoint locations of targets on the ground.

Computerized Machining Technology (MACH)

MACH students learn how to create complex precision parts from working drawings. They create the parts using both manual and Computer Numeric Controlled machines. The construction of UAS aircraft will require precise components which are likely to be produced with these methods.

Students in the Computerized Machining Technology program use the newly acquired Mazak QTN-250Y multi-axis turning center.

Aircraft Maintenance Technology (AIRM)

The ISU College of Technology's Aircraft Maintenance program includes three faculty members with a combined total of 85 years of experience and an instructor aide. All four personnel have active A & P licensure. The two senior faculty members have inspection authorization (IA) and designated mechanical examiner (DME) credentials. The AIRM program has graduated qualified technicians since the early 1950s.

The AIRM program is located adjacent to the ramp at the Pocatello Regional Airport. The facility features a large heated hangar, three classrooms, welding/metal work area, tool crib, paint booth, technical library, lab areas, and faculty offices. Additional land is available south of the facility for expansion.

Currently, the College of Technology offers training in airframe and power plant maintenance accredited by the Federal Aviation Administration (FAA). Course content is closely monitored by the FAA and all instruction is well within FAA criteria. Classroom theory is followed by "hands-on" application in the lab, which clearly sets ISU apart from other programs. FAA tasks are taught, passed off, and recorded. Instructional rigor is very high as faculty members teach students to the highest FAA standards. Students do very well on written and practical A & P tests with a pass rate of close to 95%. Placement into industry is nearly 100% as graduates work in fixed wing and rotary wing throughout the region.

Recently, the unmanned flight aviation sector has taken an uptick as unmanned flight opportunities begin to appear. AIRM graduates are highly sought after by military rotary wing units as the new UH-72 medi-vac helicopters require FAA certified technicians. The Aircraft Maintenance program has a large clientele base for conducting live work, which greatly enhances training and adds validity to the educational process. Customer aircraft are maintained and even rebuilt in some cases as a broad spectrum of work experience is provided to our students. Annual inspections are conducted for several types of fixed wing aircraft to FAA standards. Recent gifts and donations have bolstered the inventory of training aides in the last two years. Plans have been developed to acquire newer and better equipment to train students as the program continues to modernize and evolve.

ISU students perform an inspection on "Section Eight" for a client.

Enthusiastic employer support is another strong feature of the program. Not only do employers call upon faculty for student employment opportunities, but active recruiting visits take place each year for both fixed and rotary wing aircraft technicians. Employers such as Western Aircraft have eagerly sought our graduates as employees.

ISU's Aircraft Maintenance program has several strengths:

- ISU has a solid reputation with industry and has been in business since the late 1940's.
- The program is located at the Pocatello Regional Airport, which is very rural with low air traffic density.
- The facility is located in a high desert landscape with aircraft friendly terrain.
- Excellent cross winds are ideal for landing skill development.
- The RC airplane facility is co-located with the Pocatello Regional Airport and ISU Aircraft Maintenance program.

- The airport and ISU are located approximately 70 miles (by roadway) from the Idaho Nuclear Lab (INL) which conducts unmanned flight operations research.

As unmanned flight opportunities continue to present themselves, technology improves, and with the previously mentioned advantages ISU, Pocatello Regional Airport, and the INL have to offer, consideration should be given to creating additional course offerings through the Aircraft Maintenance program and industry partners.


Future courses in the AIRM program can be developed to familiarize students with unmanned flight history, communications, and sensor theory/operation. With SBOE approval, an UAS program could offer classes in airframe, power plant, robotics and other relevant courses. UAS specific classes will target the unmanned flight niche in the aviation industry. Specialization areas that could be included in an aviation cluster are calibration, repair, and services in addition to those covered in general airframe and power plant services.



Training for the new flight simulator, which was donated by Western Aircraft in September 2012.

The College of Technology can develop and implement new curriculum. To stay current with industry and offer valid training, ISU faculty work seamlessly with administrators to promote and improve curriculum, develop classes, and offer new programs in an all-inclusive effort to meet the needs of industry. The College of Technology offers substantial training opportunities directly related to UAS and will continue to refine and increase those opportunities in the future.

Department of Geosciences:

Beginning in 2009, Idaho State University began a 3-year LDRD project with the Idaho National Laboratory to develop sensor and image processing capabilities for INL's Unmanned Aerial Vehicle (UAV) program. The 3-year LDRD included research on hyperspectral sensor design, selection, procurement, calibration, and integration into an Arcturus T16 unmanned vehicle airframe. The project also included the Arcturus T16 airframe characterization, flight readiness, and flight tests over control field (INL UAV Research Park). This work resulted successful integration of a hyperspectral sensor on the Arcturus T16, along with a robust image quality validation (Hruska et al., 2012).

The LDRD led to a faculty-staff exchange for ISU post-doc Dr. Jessica Mitchell. Dr. Mitchell led a successful flight campaign with INL and the Orchard Training Area for demonstration of the hyperspectral UAV for dry land vegetation monitoring (Mitchell et al., 2012, Mitchell et al., in prep). Dr. Mitchell also led a successful $1.5M LDRD, Unmanned Aerial Vehicle-based Remote Sensing & Data Fusion for Energy & Environmental Applications, beginning in FY212 but cut in FY2013 due to INL's budget constraints. Dr. Mitchell and Dr. Nancy Glenn also led several unfunded proposals (a

Higher Education Research Council (HERC) proposal focused on UAVs and a NASA proposal focused on snow/water resource monitoring with INL and BSU).

Dr. Glenn's joint appointment with INL, beginning in FY2011, also centered around INL's UAV program. Dr. Glenn and colleagues at INL completed a comprehensive remote sensing strategic plan which included UAV remote sensing for energy and the environment, integration of UAV and ground-based terrestrial laser scanning (TLS), and other remote sensing and geospatial technologies. After a successful LDRD ($900K) beginning in FY2012, INL cut the remote sensing program.

Drs. Glenn and Mitchell continue to work with the UAV data that were collected in 2009-2011 for data validation and data fusion (Mitchell et al., in prep). Dr. Glenn's FY13 joint appoint is focused on TLS and data visualization, including the UAV data. Their expertise can be summarized as follows:

- 4 year partnership with INL on unmanned aerial vehicle research, including:
- Sensor design, calibration, integration, fusion
- Airframe characterization, flight readiness, flight tests
- Image calibration, testing, and validation
- Image classification, accuracy assessment
- Visualization, data fusion, data management
- Field data collection, validation, and integration

Their publications in the area of UAV include the following:

Hruska, R.C., Mitchell, J.J., Anderson, M.O., Glenn, N.F., 2012, Radiometric and Geometric Analysis of Hyperspectral Imagery Acquired from an Unmanned Aerial Vehicle, *Remote Sensing,* 4(9):2736-2752

Mitchell, J.J., Glenn, N.F., Anderson, M.O., Hruska, R.C., Halford, A., Baun, C., Nydegger, N., Unmanned aerial vehicle (UAV) hyperspectral remote sensing for dry land vegetation monitoring, IEEE 4th Workshop of Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, Shanghai, China, June 2012.

Mitchell, J.J., Glenn, N.F., Anderson, M.O., Hruska, R.C., Halford, A., Baun, C., Nydegger, N., Flight considerations, classifications, and accuracy of hyperspectral imagery from an unmanned aerial vehicle for dry land vegetation monitoring, *Photogrammetric Engineering and Remote Sensing*, in prep.

Drs. Glenn and Mitchell have also secured the following funding awards:

UAV and hyperspectral remote sensing, April 2009-September 2011, $41,000, Glenn, N., Idaho National Laboratory LDRD

Faculty Staff Exchange: Post-doctoral Researcher, October 2010-September 2011, $48,250, Glenn, N., Idaho National Laboratory

Unmanned Aerial Vehicle-based Remote Sensing & Data Fusion for Energy & Environmental Applications, Anderson, M., Hruska, R., Lee, R., and Mitchell, J. (lead author) $1.025 M, INL Laboratory Directed Research and Development, October 2011 – September 2014

In addition, they have worked on the following unfunded projects:

UAS Enabled Repeat LiDAR Measurements of Snow for Prediction of Water Availability, Glenn, N., Mitchell, J. (lead author), Wadsworth, D., Anderson, M., McNamara, J., Marshall, H.P., $1,399,304, NASA Research Opportunities in Space and Science (ROSES), September 2011 – August 2013

Development of a LiDAR-equipped Unmanned Aerial Vehicle System, Mitchell, J. $79,460, Idaho National Lab Energy and Environment Science and Technology Directorate – Distinguished Postdoctoral Fellowship Program, October 2011 –September 2012

HERC Incubation: ISU-INL Remote Sensing Technology Transfer for Land Management and Defense Applications, $48,300 Glenn, N. and Mitchell, J. (lead author), SBOE Idaho Incubation Fund Program, October 2011 –September 2012

Dr. Donna Delparte is a new EPSCoR faculty hire in the Geosciences department as of Fall 2012. Dr. Delparte has an extensive background in the cross-disciplinary applications of GIS and remote sensing in the fields of geosciences, resource management and conservation/environmental planning. Dr. Delparte has expertise in geographic information systems and remote sensing and was co-team lead for Cyberinfrastructure in her former position at the University of Hawaii at Hilo. Dr. Delparte is researching the use of Structure from Motion (SfM) to process data acquired from aerial data into 3D models for analysis and visualization. Her areas of application include alpine lake level monitoring and avalanche hazard mapping.

Dr. Departe's publications include:

- Delparte, D., M. Peterson, J. Jackson and J. Perkins. 2012. Modeling and visualizing avalanche flow using genetic algorithms and OpenGL. International Snow Science Workshop 2012. Anchorage, AK.
- Melrose, J. and D. Delparte. 2012. Hawaii County Food Self-Sufficiency Baseline. County of Hawaii Research and Development Department. 212pp.
- Giambelluca, T., Q. Chen, A. Frazier, J. Price, Y. Chen, P. Chu, J. Eischeid, D. Delparte. Online Rainfall Atlas of Hawaii. Bulletin of the American Meteorological Society. (http://dx.doi.org/10.1175/BAMS-D-11-00228.1)
- Delparte, D. 2011. Small-Scale Geospatial Data Repositories: If You Build It, Will They Come? Position Paper and Presentation for the First NSF CyberGIS

Project All Hands Meeting, September 28-30, Oak Ridge National Laboratory, Tennessee
- Delparte, D., Jamieson, B. and Waters, N., 2008. Statistical runout modeling of snow avalanches in Glacier National Park, Canada. *Cold Regions Science and Technology.* 54, pp.183-192.
- Delparte, D. 2008. Avalanche Terrain Modeling in Glacier National Park, Canada. PhD Thesis. Department of Geography. University of Calgary, Calgary, AB, Canada, p 179
- Delparte, D. M. 2006. The Use of GIS in Avalanche Modeling. Knowledge Media Technologies, First International Core-to-Core Workshop. No. 21, Dagstuhl, Germany.
- D'Eon, R.G. and Delparte, D. M. 2005. Effects of radiocollar position and orientation on GPS-radiocollar performance, and the implications of PDOP in data screening. *Journal of Applied Ecology.* 42(2), pp. 383-388

Department of Chemistry:

Idaho State University's Department of Chemistry includes a number of distinguished faculty who have expertise relevant to this area.

Dr. Joshua Pak is a professor of chemistry specializing in organic chemistry and materials science. His research has focused on the preparation, characterization, and properties analysis of nanoparticle precursors and he has worked in the areas of organic synthetic design, single nanoparticle precursor preparation, single precursor and nanoparticle analysis, and XRD crystallography.

Dr. Rene Rodriguez – is also a professor of chemistry specializing in the field of physical chemistry and spectroscopy. His research focus in on plasma vapor deposition of materials with semiconductor and energy cell properties including XRD crystallography, electron microscopy, and semiconductor preparation.

Dr. Andrew Holland is an associate professor of organic and inorganic chemistry. His research focus is on the preparation and characterization of organometallic compounds with potentially useful catalytic or nanoparticle properties, including organometallic synthetic design, preparation of air sensitive organometallic materials, and characterization of inorganic and organometallic compounds.

Department of Physics:

Idaho State University's Physics Department has significant experience with radiation-hardened electronic devices for the UAS. This includes:

- Environments with high levels of ionizing radiation, for example, cosmic radiation, x-ray and gamma-ray radiation, create special design challenges for systems like the UAS. Of particular importance is the effect of radiation on the electronic devices on-board an UAS.

- A single charged particle acting on a semiconductor material can knock thousands of electrons loose, causing electronic noise and signal spikes. Most semiconductor electronic components are susceptible to radiation damage. In the case of digital circuits, this can cause results which are inaccurate or unintelligible.
- High-reliability electronic components are demanded by designers of artificial satellites, spacecraft, military aircraft, and the UAS. In order to ensure the proper operation of such systems, integrated circuits and sensors on-board an UAS need to be radiation hardened.

The Idaho Accelerator Center (IAC) and the Department of Physics at Idaho State University have key capabilities and unique accelerator facilities to do research and development of radiation hardened materials suitable for the UAS.

The key capabilities of the IAC are:
- Several accelerators
- Instrumentation and mechanical fabrication support
- Radiography, tomography, and nuclear techniques for nondestructive assay
- Instrument and radiation detector testing for national security needs
- Radiation effects in biological and electronic systems
- Experienced nuclear physics and nuclear science support
- Materials analysis with positron annihilation spectroscopy

The main accelerators and laboratories at the IAC are:
- 44 MeV Short-Pulse Electron LINAC
- 25 MeV LINAC in Main Accelerator Hall
- ISIS: 7 MeV, 12kA Pulsed Electron Accelerator
- 20 MeV High Repetition-Rate Electron LINAC
- 2 MeV Positive-Ion Van de Graaff
- 4 MV Tandem Pelletron
- 48 MeV, 10kW Electron LINAC

With these unique facilities at the IAC extensive studies can be carried out on semiconductor materials to produce radiation hardened electronic devices which are demanded for reliable and safe operation of the UAS.

School of Engineering - Measurement and Control Engineering Research Center (MCERC):

The School of Engineering has an Aerospace Lab within MCERC and some time ago it purchased two UAV models, including the Aerosonde from Aerosonde Pty Ltd., and the North American Navion from North American Aviation developed by Unmanned Dynamics.

ISU's MCERC has been active in research involving UAVs. In particular, new approaches were investigated and developed by integrating hard and soft control strategies for guidance, navigation, and control of UAVs. The developed control

algorithms are incorporated in a navigation controller and UAV autopilot. The navigation controller is responsible for the generation of flyable trajectories based on desired global positioning system (GPS) waypoint destinations. The UAV autopilot is responsible for steering the UAV along these desired trajectories while maintaining stable control. Simulations were carried out using two different UAV models, the Aerosonde and the North American Navion. In addition, MCERC has equipment for implementing the developed control schemes, including two planes, remote and on board controllers, etc. The equipment was purchased in 2005 and may need investment to allow for today's software interfaces.

Faculty expertise in the MCERC includes Dr. D. Subbaram Naidu who worked on guidance and control aspects of UAVs at the United States Air Force Research Lab at Wright Patterson Air Force Base, Ohio, and Dr. Marco P. Schoen.

Department of Computer Science:

Idaho State University's Department of Computer Science includes expertise in the design of and implementation of reliable, resilient, software needed for a UAC project, image processing required for situational awareness, expertise required to manage and visualize large datasets, and information assurance/cyber security required for critical infrastructure, communications, processing and storage.

Dr. Corey Schou, ISU university professor and director of the Informatics Research Institute, leads ISU's cyber security program (National Information Assurance Training and Education Center – NIATEC), and serves as the director of the intercollege computer science program. Dr. Schou's NIATEC program is funded by the National Security Agency and the National Science Foundation. Dr. Schou has designed systems simulators and visualization systems for major airlines and Boeing.

Dr. David Beard is professor and chair of the computer science department and has published extensively in databases, human computer interaction, and image display. He has industrial experience constructing large software systems.

GIS Training and Research Center

The GIS Training and Research Center (GIS TReC) has developed an active rangeland research program. As part of this program, the use of high-resolution aerial imagery has become increasingly important for the identification of new weed invasions and plant community identification. These data, including imagery acquired using UAV has been part of several studies at the GIS TReC.

The GIS Director, Keith T. Weber is involved with ISU faculty and others across the region in exploring the use of UAV's for scientific purposes.

BOISE STATE UNIVERSITY

RESEARCH AND ECONOMIC DEVELOPMENT

ADVANCED AVIATION SOLUTIONS

AN INVENTORY OF UNIVERSITY ASSETS

Boise State's College of Engineering has developed strengths in a number of key areas with direct application for the development of unmanned aerial systems. The growth and dynamism the College and its University have experienced in recent years underscores our ability to contribute to and lead UAS research and development.

OVERVIEW

WITH MORE THAN 22,000 STUDENTS ENROLLED IN ITS UNDERGRADUATE, GRADUATE AND DOCTORAL PROGRAMS, Boise State is Idaho's largest university. Nearly one-third of the university's enrollment growth from 1997–2010 has been in the College of Engineering. Since 2004, enrollment among engineering majors has increased nearly 49 percent, an indication of both the demand for these programs, and the success of the College in managing the pace of growth while also maintaining program quality and rigor.

Student interest in engineering disciplines continues to be high: During the past two years, undergraduate enrollment has grown by more than 30%. During that time period, Mechanical Engineering enrollment has grown by 54% and Computer Science by nearly 44 percent.

THE COLLEGE OF ENGINEERING OFFERS DEGREE PROGRAMS IN SEVEN DEPARTMENTS: Civil Engineering (CE); Computer Science (CS); Construction Management (CM);Electrical & Computer Engineering (ECE); Instructional & Performance Technology (IPT); Materials Science & Engineering (MSE); and Mechanical & Biomedical Engineering (MBE).

NOVEL MATERIALS DEVELOPMENT IS A PARTICULAR AREA OF STRENGTH WITHIN THE COLLEGE. Researchers have secured more than $11 million in external funding over the last two years for research programs focused on nuclear fuels and materials, biomaterials, glasses, semiconductors, electronic memories, minerals, computational modeling, energy materials and magnetic materials. Our faculty collaborate with top research institutions in the United States and around the world. In June 2012, the college's Department of Materials Science and Engineering hosted the Fourth International Symposium on Ferromagnetic Shape Memory Alloys, which attracted over 150 researchers from around the world.

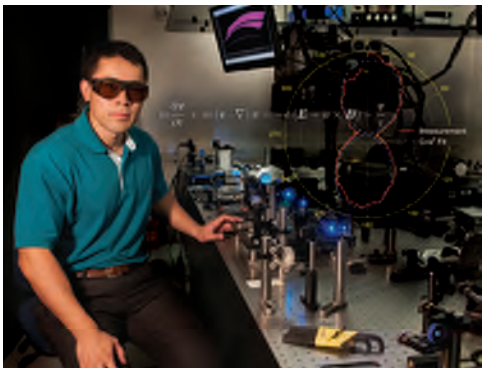
Dr. Peter Mullner is the inventor on patents involving magnetic shape-memory alloys.

Drs. Bill Knowlton, left foreground, and Will Hughes are among faculty and students in the Nanoscale Materials and Device Group.

DEPARTMENT CONTRIBUTIONS

THE CIVIL ENGINEERING DEPARTMENT has deep connections with state agencies and this existing infrastructure may be useful in facilitating state partnerships.

THE COMPUTER SCIENCE AND ELECTRICAL & COMPUTER ENGINEERING DEPARTMENTS could help inform communication system development as well as cybersecurity, reliability, and managing large data sets. Research areas include chalcogenide glasses, microwave vacuum electron devices, nanophotonics, through-wafer interconnects, reconfigurable electronics, new electronic memory technologies, nanoionic materials, e-beam lithography, and integrated photonic transceivers for optical communications.



Dr. Wan Kuang studies nanophotonic materials and devices, research that could lay the groundwork for miniaturizing optical devices.

In addition, the Computer Science Department is adding four new faculty members based on funding from the Idaho Global Entrepreneurial Mission (IGEM), a statewide initiative to create new enterprises and high-paying jobs in Idaho's knowledge economy by increasing strategic areas of research and development through targeted partnerships among industry, higher education and government. These new faculty positions are targeted for scientists with expertise in databases and software.

THE MATERIALS SCIENCE & ENGINEERING DEPARTMENT is growing rapidly and could offer deep expertise regarding the impact of specific materials on UAS design and manufacture. Such materials could include nanomaterials, where we have unique expertise. Other research addresses 3D technology for advanced sensor systems, magnetic shape-memory alloys, solid-oxide fuel cells, gate oxide characterization, biomaterials, grain boundary corrosion, nuclear fuels and materials, ceramics, graphite, and high temperature materials.

Largely in response to demands in the Boise metropolitan area, the College of Engineering established a Materials Science master's degree program in 2003, a bachelor's degree program in 2004, and a doctoral program in 2012. One of the research groups, the ten-year old **Nanoscale Materials and Device Group**, includes multidisciplinary research faculty and students and is among only a handful of research groups in the nation using DNA nanotechnology to fabricate nanoscale devices.

Between 2004 and 2010, the Materials Science & Engineering department's graduate student population quadrupled, and enrollment is at a record 93 undergraduates. Micron Technology—one of the world's leading semiconductor companies—committed $13 million in funding with one of the largest gift to the university in its nearly 80-year history that helped launch the Materials Science & Engineering doctoral degree program.

Distinguished Educator-in-Residence and former astronaut Barbara Morgan, right, discusses a remotely powered aircraft with student team members.

THE MECHANICAL & BIOMEDICAL ENGINEERING DEPARTMENT could offer expertise related to product development and aviation. A student team for which Don Plumlee served as an advisor celebrated a first-place overall win in the advanced category of the **2012 SAE Aero Design West** competition held in Van Nuys, California this March. They designed, built, and flew a remotely piloted aircraft capable of carrying a high payload while meeting strict competition specifications.

DEPARTMENT CONTRIBUTIONS, CONTINUED

Mechanical & Biomedical Engineering professor **Inanc Senocak** has recently obtained funding to build a new computer cluster utilizing GPU and CPU parallelization. This new system will bring a significant computing facility to Boise State University. The system will include a 64 node CPU cluster with 44 NVIDIA Tesla M2075 cards providing massive parallel processing capability, and 20 NVIDIA Quadro 6000 graphics cards driving a tile display of 40 thirty inch monitors with a combined resolution of 163 megapixel. The combination of the massive computational power of this system combined with the ultra-high display will provide a state of the art modeling and visualization resource to the university. This system will be available to researchers across campus beginning in the summer of 2013

RESEARCH STRENGTHS IN THE COLLEGE OF ENGINEERING

In addition to Novel Materials development, the College's researchers have expertise in Sensors, Image Processing, Systems Control and Environmental Monitoring.

SENSORS

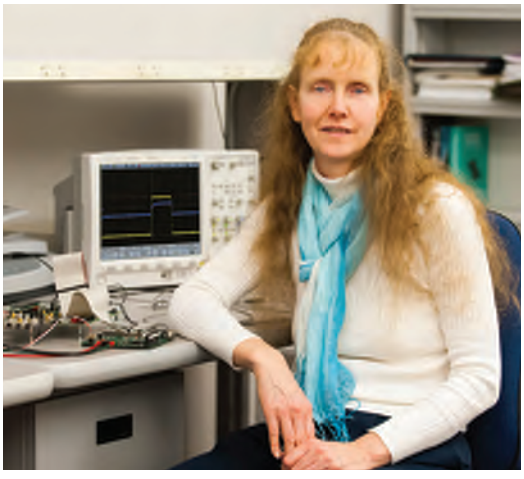
Sin Ming Loo, Professor and Chair, Electrical and Computer Engineering. Loo is the principal investigator for the FAA's National Center for Research Excellence in the Intermodal Transport. Loo's research interests are in the areas of scheduling, parallel processing, computational science, embedded system, hardware/software codesign, sensor systems, and reconfigurable computing

In addition to the work Loo is pursuing, it's worth noting that Boise State has an active group of researchers addressing sensors in general:

Hao Chen, Assistant Professor, Electrical & Computer Engineering. Chen's research interests include communication systems and sensor networks, especially safety and reliability issues.

Maria Mitkova, Associate Professor, Electrical & Computer Engineering. Mitkova is an internationally recognized researcher in sensor and memory technologies that leverage the use of chalcogenide ("cal-cog-e-nide") glass. She is familiar with aircraft (NASA), reliable sensors and memory devices that could help inform effective UAS craft operations, and is knowledgeable about safety issues (as with the nuclear industry). The inventor on six U.S. patents, Mitkova has specialized in a number of Ag-containing chalcogenide systems and their application in ionic nonvolatile programmable metallization cell memory devices, optical displays, MEMS and devices for microfluidic control. Research crosses interdisciplinary boundaries between electrical and computer engineering, physics, and materials science.

Mitkova submitted a grant to NASA recently on New Materials Research Solutions for Improved Performance of Conductive Bridge Memory Devices for Space Applications. A primary research aim for that effort is to address maintaining scientific equipment performance in environments with wide ranging temperatures. She also recently submitted a proposal with the Department of Energy on advanced radiation sensor design for nuclear safety in particular that she believes will offer increased sensor system accuracy, reliability and efficiency.



Dr. Elisa Barney Smith is among faculty with extensive expertise in image processing.

IMAGE PROCESSING

An unmanned vehicle has photographic video feeds as well as a lot of wireless data communication, systems that align with the research programs of several faculty members. Both **Elisa Barney Smith** in ECE and **Tim Andersen** in CS have extensive expertise in image processing.

SYSTEMS CONTROL

John Chiasson, Associate Professor, ECE, is a systems control researcher.

ENVIRONMENTAL MONITORING

We have a number of faculty members addressing environmental issues and monitoring technologies. **Sondra Miller** in Civil Engineering makes extensive use of environmental field monitoring. **Gang-Ryung Uh** in CS recently submitted a proposal about a wireless monitoring system making use of the radio spectrum that they wanted to put in place for examining agricultural areas.

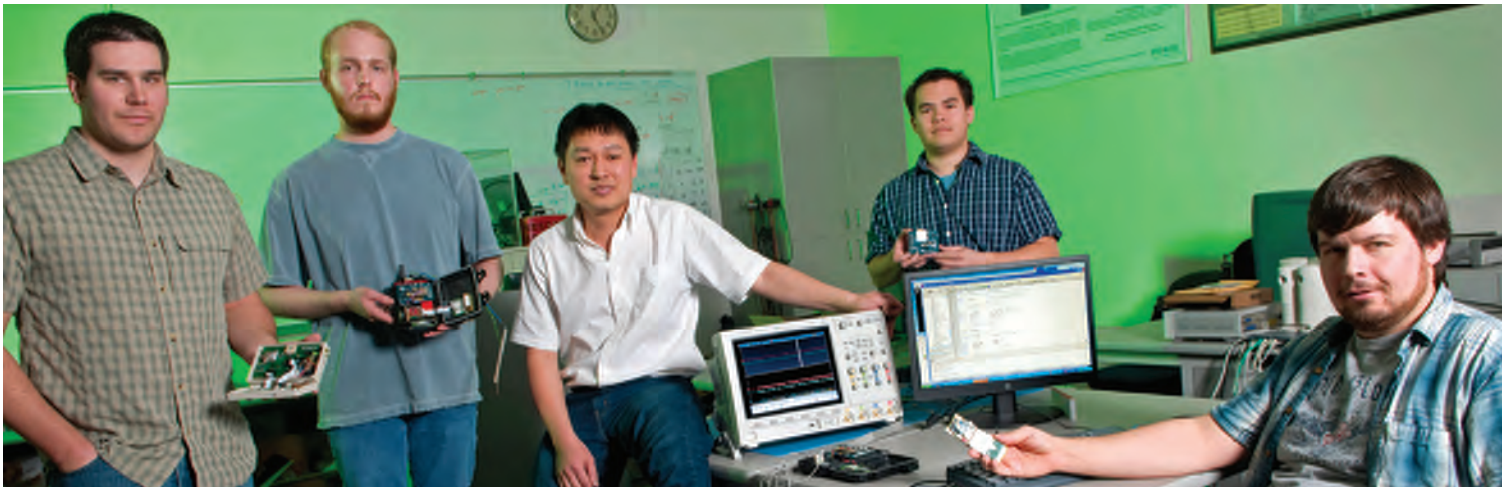
In addition, there is a breadth of research interests in environmental stewardship across the university, demonstrated, for example in a sustainability minor under discussion that folds in research and coursework from biology to anthropology, sociology to economics, history to political science.

CURRENT OR RECENT PROJECTS: SENSORS AND PROPULSION

Two projects are related to aeronautic sensor systems:

1) SENSORS AND PROGNOSTICS TO MITIGATE BLEED AIR CONTAMINATION EVENTS – Funded by the FAA ($389,000) This project evaluates how we can use real-time sensing systems and wireless sensor networks to sense the quality of bleed air, and the use of CO, CO2, particle-counters, and other sensors to test incoming air.

2) IN-FLIGHT SENSOR SYSTEMS AND DATABASE DEPLOYMENT – Funded by the FAA ($205,000). This project is to develop and design prototype sensor systems to study operating cabin conditions. The current designs include CO2, temperature, humidity, pressure, and sound level. Next generation systems will include SpO2 and particle counters.



Dr. Sin Ming Loo, center, and his students have have developed wireless, reconfigurable and portable sensor systems for monitoring and recording environmental conditions inside aircraft cabins.

In addition, two projects are specifically related to aerospace applications, both in micro-propulsion of satellites.

The trend towards miniaturization of satellites down to even a 10cm cube requires a corresponding reduction in thrust to provide directional control in orbit. We have worked in two areas of micro-propulsion:

1) CHEMICAL PROPULSION - Funded by NASA through ISGC ($30K) and DOD through DEPSCoR ($500K). This project continued from 2003-2010 in various forms to produce a hydrogen peroxide monopropellant device using a novel multi-layered ceramic substrate called Low Temperature Co-Fired Ceramics (LTCC). We have developed a test facility certified for hydrogen peroxide operation and a schlieren optical work bench for visualizing the nozzle plumes down to sub mm sizes.

2) ELECTRICAL PROPULSION - Funded by NASA from 2008 through 2013 ($30K through ISGC and $750K through NASA). This project uses the same LTCC material to develop more efficient thrusters using electrical power to provide the propulsive thrust by accelerating ions electrostatically. In this project we have developed a vacuum test chamber, thrust stand and a variety of power electronics to control and test the devices.

COEN FACULTY EXPERTISE IN ENVIRONMENTAL SENSOR DEVELOPMENT AND APPLICATION

Dr. Inanc Senocak's wide-ranging research includes developing massively parallel wind simulation software designed to enhance the speed and accuracy of wind forecasting.

Dr. Don Plumlee, left, has expertise in sensor design, sensor and device fabrication using LTC ceramic substrates, and other research areas.

Novel materials for extreme environments is a research focus for Dr. Darryl Butt.

Inanc Senocak

Mechanical & Biomedical Engineering
Assistant Professor

- Wind forecasting
- Weather modeling
- Fluid dynamics
- Finite Element algorithm development
- GPU computing
- Visualization
- Data fusion/mining
- Wireless senor network architecture

Don Plumlee

Mechanical & Biomedical Engineering
Asst Professor

- Sensor design
- Sensor and device fabrication using LTC ceramic substrates
- Energy scavenging device design and fabrication
- Fluid dynamics
- "Lab-on-a-Chip" miniaturization

Vishal Saxena

Electrical & Computer Engineering – Asst Professor

- Analog – Digital ADC device design
- Delta-sigma ADC design
- Broadband communications system design
- Wireless senor system architecture
- Sensor fusion
- Energy harvesting
- Ultra-low power circuit design

Hao Chen

Electrical & Computer Engineering
Asst Professor

- Statistical signal and image processing
- Wireless senor networks
- Distributed inference
- Noise enhanced signal processing
- Cognitive radio design

Sin Ming Loo

Electrical & Computer Engineering
Professor & Chair

- Digital systems design and fabrication
- Embedded systems design
- Wireless sensor system design, prototyping and fabrication
- Hardware and software co-design
- Field Programmable Grid Array (FPGA) implementation

Maria Mitkova

Electrical & Computer Engineering
Assoc Professor

- Electronic materials physics
- Modeling, design and fabrication utilizing chalcogenide materials systems
- Development of GaAs NO2 environmental sensor
- Development of chalcogenide based radiation sensor
- Fabrication of bio-lab chip

Darryl Butt

Materials Science & Engineering
Professor & Chair

- Materials design processing
- Materials in extreme environments
- Electro-chemical sensor design and fabrication
- Development and commercialization of oil-contamination sensor

Peter Müllner

Materials Science & Engineering
Professor

- Materials design and processing
- Magnetic shape memory alloys (MSMA)
- MSMA energy harvesting devices
- MSMA sensors and devices
- Miniature device design and fabrication

COEN FACULTY EXPERTISE IN VISUALIZATION AND CYBER-INFRASTRUCTURE

Alark Joshi
Computer Science
Asst Professor

- Illustration-inspired computer graphics
- Visualization for neurosurgical planning and inter-operative use
- Time-varying data visualization
- Scientific visualization and computer graphics

Amit Jain
Computer Science
Assoc Professor

- Parallel computing
- Beowulf clusters
- Operating systems

Dr. Amit Jain's research interests include parallel systems and languages, Beowulf clusters, parallel system hardware/software design, parallel application development, parallel algorithms and data structures.

Boise State University is committed to fostering an environment where research and creative activity thrive. The Division of Research and Economic Development leads this effort. We provide comprehensive support for faculty during all phases of the research endeavor; manage the university's intellectual property portfolio; facilitate relationships with industry for research and commercialization collaboration; and lead outreach aimed at fostering economic development in Boise and the region.

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BOISE STATE UNIVERSITY

University of Idaho

Many current issues facing Idaho and beyond relate to understanding processes occurring in areas that are difficult and/or dangerous for people to access using ground-based or traditional fixed-wing methods. As a result, faculty within the Colleges of Natural Resources, Agricultural and Life Sciences and Engineering at the University of Idaho have experience with (A) Unmanned Aerial System (UAS) sensor development and platform design, as well as (B) many applications relevant to UASs including (C) educational outreach. This work has occurred along varied lines of inquiry as a result of a diverse array of funding from Federal and State agencies.

A) Sensor and platform development and design

The faculty at the College of Natural Resources (CNR) has strong expertise in remote sensing sensor development and testing of relevance for developing and improving UAS technology to address environmental science and management questions. For example, the following projects and associated publications highlight efforts in sensor and platform development and design:

- Design and development of an aerial tethered balloon remote sensing platform (the Short Wave Aerostat Mounted Imager, or SWAMI) with passive and active image stabilization systems capable of acquiring hyperspectral remote sensing data (Fig. 1). This platform was developed via NSF grant funding to Dr. Lee Vierling (titled "CAREER: An Integrated Research/Educational Plan to Develop and Deploy a Pointable, Hyperspectral Remote Sensing Instrument on a Tethered Balloon") and fully described in Vierling et al., 2006.

Figure 1. Short Wave Aerostat-Mounted Imager (SWAMI) platform and sample image acquired from ca. 300m elevation.

- Dr. Paul Gessler and Ph.D. student Peter Gorsevski led an effort to design and the develop a hyperspectral and multispectral airborne mapping system to fly on a fixed-wing light aircraft for use in diverse applications (Fig. 2, described in Gorsevski and Gessler, 2009).

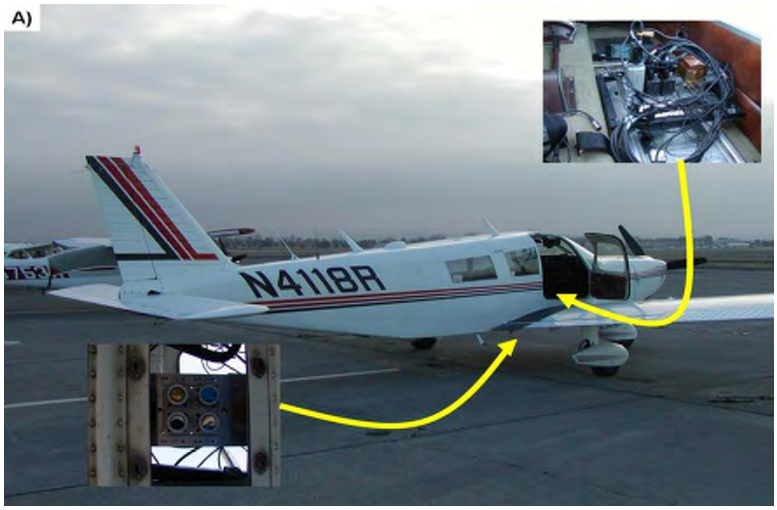

Figure 2. Hyperspectral and multispectral airborne mapping system designed and tested at CNR.

- Two efforts have worked to develop a UAS capable of sampling physical samples of foliage and seeds (cones) from the tops of trees. One effort was led by Dr. Mark Coleman and the other by Dr. Katy Kavanagh and Dr. Herb Hess (UI College of Engineering). Both efforts are in collaboration with University of Idaho College of Engineering students through the Senior Design course process. These efforts of direct sampling could be combined with remote sensing capabilities on a single UAS.

- Dr. Vierling and Ph.D. student Steve Garrity developed, tested, and implemented lightweight (~200g), low power, narrowband (10nm bandwidth) radiometers suitable for measuring irradiance and radiance on board UASs to determine plant health status (Garrity et al., 2010; Magney et al., 2012) among other surface characteristics. These sensors are now under commercial production by Decagon Devices, Inc.

- Dr. Jan Eitel has led the development and testing of a lightweight, autonomously operating terrestrial laser scanner for monitoring 3-dimensional dynamics of surfaces (e.g. erosional processes, vegetation change, movement of cars and other objects) at very high spatial and temporal resolution (Eitel et al., 2012a). Such a system could be implemented in a UAS due to its light weight and low power consumption.

- In collaboration with a German company, Dr. Eitel has also led the testing of a two-wavelength laser system intended to improve nitrogen fertilizer management in agricultural systems (Eitel et al., 2012b).

B) Applications of UASs for current research

Faculty in CNR are currently involved in several research efforts that could benefit from the use of UASs. These research efforts include:

- Dr. Mike Scott (CNR), Dr. Oz Garton (CNR), and Pete Zager (Idaho Dept. of Fish and Game) have worked for the past 10 years to develop and test the concept of UASs as a potential replacement for dangerous work by biologists flying aerial surveys for elk, deer, pronghorn antelope, bighorn sheep, greater sage-grouse and salmon redds. This work was done under the auspices of the Cooperative Fish and Wildlife Research Unit in CNR starting prior to 2003. In addition, Dr. Garton has conducted numerous projects developing sightability models to correct surveys of wildlife and fisheries for visibility bias when flown with helicopters and fixed wing.

- Drs. Alistair Smith and Luigi Boschetti have developed a great deal of expertise in understanding the energy release of fires, and in mapping fire perimeters (e.g. Roy, Smith, and Boschetti, 2013). UASs would allow for high spatial resolution mapping of fire perimeters and energy release to narrow model uncertainties and error in this important field.

- Dr. Janet Rachlow is currently leading an effort to map habitat characteristics in sagebrush using UASs. Dr. Rachlow's team has contracted with the University of Florida Cooperative Fish and Wildlife Research Unit (funded via NSF grant proposal DEB-1146166 "Collaborative Research: Modeling Tradeoffs within Food-, Fear-, and Thermal-Scapes to Explain Habitat Use by Mammalian Herbivores") to conduct UAS flights over 3 study areas in summer 2013 (late June) and again in the winter. The objective is to obtain high-resolution (2 cm) images of vegetation cover and to use NIR image data to evaluate and map variability in plant chemistry in the sagebrush.

- Dr. Timothy Link has considerable expertise in studying snow-covered area in highly inaccessible mountainous terrain. UASs could improve snow covered area (and potentially, snow volume) assessments to validate and improve snow models. This work would complement ongoing work at the Reynolds Creek Experimental Watershed in S. Idaho and beyond.

- Dr. Jim Gosz sits on the NSF National Ecological Observing Network (NEON) board of directors, and several CNR faculty are exploring the use of the NEON Airborne Observing Platform (AOP) at their field study sites. The AOP has hyperspectral and lidar data collection capabilities that could be the source of evaluation, validation, and testing of UAS capabilities within myriad ecological research contexts. For example, Drs. Vierling and Eitel will be conducting work at the Toolik Lake NEON site in N. Alaska under a NASA-funded project ("Quantifying Thresholds in Arctic Tundra Vegetation Structure and Ecosystem Function Using LiDAR and Multispectral Remote

Sensing") joint with Columbia University where the NEON AOP will be flying in 2014. The relatively low deployment costs and relatively high level of safety of UAS relative to the AOP opens excellent new opportunities for such applications.

- Drs. Vierling and Eitel are currently conducting research (funded by USDA-NIFA Climate Change Program project "Site-specific Climate Friendly Farming") to reduce nitrous oxide emissions (a trace gas with high greenhouse warming potential) from agricultural systems. Because variation in soil moisture, N availability, and crop productivity can vary greatly over short distances in cropping systems, high resolution remote sensing data is useful to reduce observation and model error. UASs could provide data fundamental to minimizing these uncertainties and complement high temporal resolution data collected by other means. UAS application in agriculture could also open up new opportunities for farmers to manage their crops (e.g. irrigation, pesticide, herbicide, fertilizer application).

C) Outreach

CNR faculty also have expertise in developing and delivering outreach to K-12 students and teachers that focuses on remote sensing with the ultimate goal to engage students to seek careers in STEM fields. During a 5-day geospatial summer camp taught by CNR remote sensing faculty, K-12 students used commercially available, low cost ($300 as of 2013) UAVs to remotely map land cover types (Fig. 3).

Figure 3. Use of a commercially available UAV for remotely mapping land cover type.

D) Current proposal development efforts

CNR faculty are active in developing proposals in many of the application areas listed above. For example:

- Dr. Rachlow is currently developing further collaborations with USFWS colleagues on Kodiak Island, AK to explore use of UASs for mapping berry-producing shrubs and other forage for bears. This work is in current discussion with the USGS UAS team in Denver for budget scoping.

- Drs. Eitel and Vierling are currently developing a NSF Major Research Instrument Program (MRI) proposal joint with researchers at Washington State University with the goal to design remote sensing instrument pods for deployment on small fixed wing aircraft to conduct research in ecology, atmospheric chemistry, and hydrology.

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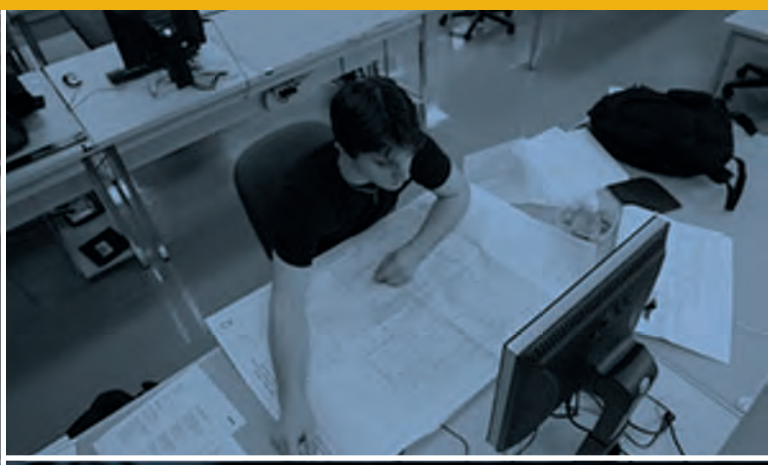
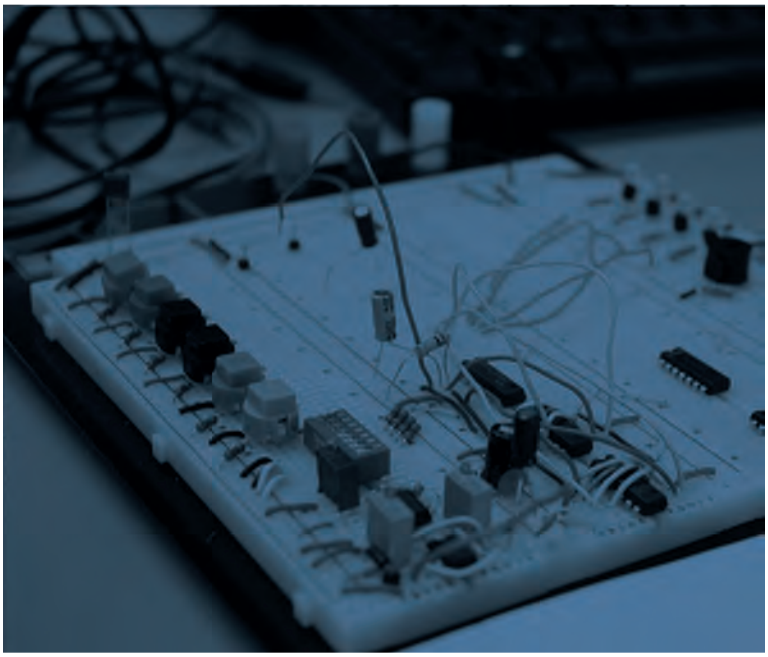
Vierling, L. A., Fersdahl, M., Chen, X., Li, Z., and Zimmerman, P. R. (2006). The Short Wave Aerostat-Mounted Imager (SWAMI): A novel platform for acquiring remotely sensed data from a tethered balloon. *Remote Sensing of Environment, 103*, 255-264.

College of Western Idaho

Professional
Technical Education

Unmanned Aircraft Systems Inventory





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Unmanned Aircraft Systems Inventory

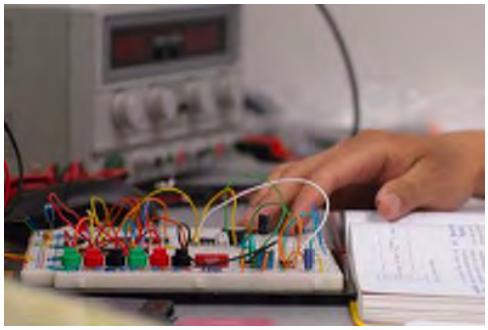
January 31, 2013

Located in the heart of the Treasure Valley, the College of Western Idaho is the newest and fastest growing Community College in the State of Idaho. In fall of 2012 CWI served 9107 credit students and 9521 non-credit students. CWI conferred 647 degrees and certificates in the 2011-2012 academic year.
The College of Western Idaho has extensive technical training providing expertise that relates directly to the technical and technician training aspects of Unmanned Aircraft Systems. Additionally, CWI offers 28 general education transfer Associates of Arts, and Science degrees that are foundational for higher degrees awarded by our University partners, BSU, C of I, ISU, NNU, U of I, and University of Phoenix.

Professional Technical Education:

The College of Western Idaho's Professional Technical Education programs are highly intensive educational programs focused on providing skills that lead to employment in business and industry. The training provided in many of the PTE programs relates directly to training for UAS technicians in a variety of ways. This education and technology can be found primarily in programs such as Electronics Technology, Drafting Technology, and Machine Tool Technology.

Students graduating from PTE program at the College of Western Idaho provide a highly skilled labor pool for high-tech business and industry in and around the Treasure Valley. Students are recruited from the Electronics Technology, Drafting Technology, and Machine Tool Technology for employment in a broad variety of technical fields including avionics and UAS related fields to provide technical design, manufacturing, and operational support services. College of Western Idaho PTE programs related to UAS include:



Electronics Technology (ELTC)

The two year Electronics Technology program covers numerous areas related directly to UAS manufacturing and UAS implementation. Although not directed toward UAS at this time the topics relate directly and students graduating from the program would have knowledge that would be easily transferable to the UAS field. Students graduate with an Associate of Applied Science Degree.

Wireless
Communications
Our current program has students investigating a wide variety of wireless communications techniques, from the basic analog techniques of amplitude, frequency, and phase modulation schemes to the more advanced techniques of Quadrature Amplitude Modulation, DSSS (Direct Sequence Spread Spectrum), OFDM (Orthogonal Frequency Division Multiplexing) and CDMA (Code Division Multiple Access). Many of the wireless technologies covered offer an introduction into the fundamentals of some popular techniques used today, including Bluetooth, Zigbee, WiMax, ultra-wideband, and wireless LAN protocols.

Students are given practical hands-on experience designing, testing, and troubleshooting transmitter and receiver circuits, multiplexors/demultiplexors, and frequency synthesizers. Once this knowledge is gained students must then take the information into the wireless realm by designing and constructing impedance matching circuits for maximum transfer of energy via transmission line and antenna theories and propagation analysis.

Software
Circuit Simulation Software:
Used to prototype test and evaluate circuit function and design, the software is a circuit simulation that can provide a student with an idea of the function of a circuit and what to expect before the circuit is built. In addition, the software can demonstrate errors and possible malfunctions of circuits. The trouble shooting skills students develop would apply to UAS technicians maintain UAS equipment.

C++, Visual C and Basic programming platforms:

> These programs are used demonstrate the function and structure of programs. They provide a student with a platform for learning the structure, function, and requirements of a program. In addition, many of these programs are used by students to complete course assignments as well as in final projects that they design, develop, build, and present.

These student designed projects require students to interface multiple processor systems to one another to control and monitor specific requirements.

Electromechanical
Students cover DC motors extensively throughout the program, as well as learn numerous related areas of Electromechanical systems. These areas include gearing, stepper motors, and pneumatic and hydraulic systems, all of which are related directly to UAS technology, production and use.

Sensors
Micro-electromechanical system (MEMS), global positioning sensors (GPS), and ultrasonic and infrared sensors used throughout the program in a variety of formats. These sensor technologies all relate directly to UAS technology.

Drafting Technology (DRFT)

CADD is the advanced computer software used for the design, analysis and output of technical drawings and 3-dimensional models. CADD is used extensively in many applications including automotive, shipbuilding, and aerospace industries. The software's inherent numeric/geometric parameters allow the designer (student) to create, explore, modify, and refine 3D models. Design validation tools facilitate advanced engineering technologies such as thermal analysis, flight pattern analysis, and virtual prototyping for creating and testing of models such as UAS aircraft. Students have designed and modeled prototype and wirelessly controlled rotary and fixed wing aircraft as part of their student projects.

Machine Tool Technology (MACH)

Modern Computer Numerically Controlled (CNC) machining practices involve programming, setup, and operation of equipment that has highly evolved from the early days of its predecessors. The skills necessary to competently produce precision parts on these machines involve the use of CAD/CAM systems, math, metrology, tooling identification, and jigs & fixture design. CNC machines are capable of producing parts to exacting tolerances that are supplied to the automotive, medical, aviation, and aero-space industries, including the evolving field of UAS aircraft (drones).

Workforce Development:

CWI's Business Partnerships and Workforce Development department provides short-term, intensive, non-credit training for business and industry. BP/WD currently has expert staff in related fields such as safety and electrician training. Courses provided by BP/WD can be customized to meet the needs of employers and students who are focused in the UAS and avionics industries to update skills and abilities or provide new skill training for the existing workforce. These courses, which are provided by industry experts, are highly customizable and provided in a variety of formats for ultimate flexibility.

General (Transfer) Education:

Currently the College of Western Idaho has numerous courses and several degree areas that form the foundational studies of future, engineers, controllers, and technicians in the UAS field. Although the programs in the General Education area as designed primarily to pride a student the courses that will prepare them for transfer to a University to finish a Baccalaureate degree, they also provide the foundation knowledge of future UAS employees. Fields that relate directly to UAS systems provided by the College of Western Idaho General Education Division are: Mathematics, Physics, Chemistry, Geography, and Geology.
Additionally, CWI is working to begin to provide a transfer associate degree in the Engineering fields.

Summary:

College of Western Idaho faculty has great depth of knowledge and exceptional experience in professional technical training. We work closely with all educational institutions both in the Treasure Valley and across the State.

CWI maintains articulations agreements with all State and many private Universities. Additionally, CWI works closely with the College of Southern Idaho and North Idaho College. CWI maintains valuable relationships with business and industry and relies on Technical Advisory Committees to influence curriculum and offerings at the institution and assure that students are well placed to gain employment after they complete their education. As the community college tasked with serving the largest population center of the state, CWI would offer great resources as a partner in all UAS activities in Idaho.

Idaho Division of Aeronautics

UAS Inventory

February 26, 2013

The State of Idaho is home to 126 public airports. As the 9th geographically largest state, public airports represent a very important aspect of the state's transportation infrastructure.

Idaho Airspace

Controlled Airspace:

There is no Class B airspace within the State of Idaho.

Class C airspace is located at the BOI Airport. It extends from the surface to 4,000' AGL within a 10 mile radius.

Class D airspace is located at each of the primary airports mostly during daylight hours. The airspace extends to 2500' AGL and within an area covering an instrument approach maneuvering area.

Class E airspace is located near airports with instrument approaches, as extensions to Class C and D airspace and federal airways.

Restricted airspace is located south of BOI in a 15x15 mi area, south of Mountain Home in a 20x20 mi area and north of Murphy Hot Springs in a 8x8 mi area.

Military Operations Area airspace is located in the extreme southwest corner of the state in a 100x100 mi area.

Idaho Airports

Idaho has six primary commercial airports, Idaho Falls, Pocatello, Hailey, Boise, Twin Falls and Lewiston. All have airline service, however, none are at full airline capacity. Each primary airport with the exception of Hailey has land available for development.

Idaho is home to 31 GA NPIAS (National Program of Integrated Airport System) airports. The largest of these are Coeur d 'Alene, Sandpoint, McCall, Driggs, Nampa and Caldwell.

Airport Climatology

BOISE AIRPORT, IDAHO

Period of Record Monthly Climate Summary

Period of Record : 1/ 1/1940 to 9/30/2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	37.1	44.4	53.1	61.7	71.1	79.9	90.9	88.6	78.1	64.8	48.5	38.6	63.1
Average Min. Temperature (F)	22.6	27.5	32.1	37.4	44.7	51.9	58.9	57.6	49.3	39.7	30.7	24.0	39.7
Average Total Precipitation (in.)	1.40	1.07	1.25	1.20	1.29	0.84	0.25	0.28	0.55	0.81	1.32	1.42	11.70
Average Total SnowFall (in.)	6.2	3.3	1.6	0.5	0.1	0.0	0.0	0.0	0.0	0.1	2.0	5.8	19.6
Average Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	1	0

Percent of possible observations for period of record.
Max. Temp.: 99.9% Min. Temp.: 99.9% Precipitation: 99.9% Snowfall: 99.9% Snow Depth: 98%

IDAHO FALLS ARPT, IDAHO

Period of Record Monthly Climate Summary

Period of Record : 8/ 1/1948 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	27.0	33.7	44.0	56.8	67.0	76.2	85.8	84.4	73.6	60.3	42.4	30.0	56.8
Average Min. Temperature (F)	10.0	15.3	23.5	31.2	39.0	45.5	50.8	49.1	40.6	31.1	22.1	12.6	30.9

Average Total Precipitation (in.)	0.76	0.74	0.75	0.89	1.38	1.19	0.54	0.70	0.72	0.75	0.82	0.80	10.03
Average Total SnowFall (in.)	8.7	6.4	3.8	2.2	0.5	0.0	0.0	0.0	0.0	0.7	4.5	8.6	35.3
Average Snow Depth (in.)	5	4	2	0	0	0	0	0	0	0	0	3	1

Percent of possible observations for period of record.
Max. Temp.: 99.9% Min. Temp.: 99.9% Precipitation: 99.9% Snowfall: 100% Snow Depth: 100%

POCATELLO ARPT, IDAHO

Period of Record Monthly Climate Summary

Period of Record : 1/ 1/1939 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	32.5	38.3	47.4	58.2	68.2	77.5	88.4	86.8	75.8	62.5	45.2	34.9	59.6
Average Min. Temperature (F)	15.2	19.8	26.2	32.9	40.4	46.8	53.2	51.6	42.8	33.6	24.8	17.6	33.7
Average Total Precipitation (in.)	1.10	0.92	1.12	1.12	1.35	1.02	0.53	0.61	0.79	0.87	1.05	1.07	11.54
Average Total SnowFall (in.)	9.4	6.5	5.4	3.5	0.4	0.0	0.0	0.0	0.0	1.8	4.6	8.6	40.3
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

Percent of possible observations for period of record.
Max. Temp.: 100% Min. Temp.: 100% Precipitation: 100% Snowfall: 100% Snow Depth: 94.6%

TWIN FALLS, IDAHO

Period of Record Monthly Climate Summary

Period of Record : 4/13/1963 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual

Average Max. Temperature (F)	36.0	41.5	50.6	58.4	67.6	76.1	85.2	84.1	74.4	63.0	47.2	37.0	60.1
Average Min. Temperature (F)	19.9	23.0	28.5	33.6	41.4	48.0	53.2	51.4	43.1	34.2	26.8	19.9	35.3
Average Total Precipitation (in.)	1.22	0.80	1.08	1.07	1.28	0.89	0.28	0.48	0.61	0.68	1.17	1.25	10.80
Average Total SnowFall (in.)	6.6	4.7	3.0	1.4	0.5	0.0	0.0	0.0	0.1	0.2	3.5	6.3	26.3
Average Snow Depth (in.)	1	1	0	0	0	0	0	0	0	0	0	1	0

Percent of possible observations for period of record.
Max. Temp.: 99.6% Min. Temp.: 99.5% Precipitation: 99.5% Snowfall: 99.8% Snow Depth: 99.7%

HAILEY 3 NNW, IDAHO (103942)

Period of Record Monthly Climate Summary

Period of Record : 8/ 1/1948 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	30.2	36.5	42.0	55.2	65.5	74.4	84.8	83.6	74.1	61.5	44.4	33.0	57.1
Average Min. Temperature (F)	7.8	12.7	18.8	28.8	36.6	42.8	48.9	47.4	39.3	31.2	21.0	11.3	28.9
Average Total Precipitation (in.)	2.58	1.82	1.23	1.05	1.49	1.31	0.43	0.63	0.75	0.72	1.57	2.30	15.89
Average Total SnowFall (in.)	25.4	15.1	7.9	1.1	0.8	0.0	0.0	0.0	0.1	0.8	7.5	22.5	81.1
Average Snow Depth (in.)	19	23	12	1	0	0	0	0	0	0	1	9	5

Percent of possible observations for period of record.
Max. Temp.: 82% Min. Temp.: 82.1% Precipitation: 84.7% Snowfall: 81.5% Snow Depth: 71.6%

LEWISTON AIRPORT, IDAHO

Period of Record Monthly Climate Summary

Period of Record : 8/ 1/1948 to 12/31/2005

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	39.6	46.3	53.8	62.1	70.7	78.8	89.1	88.0	77.8	62.9	47.9	40.6	63.1
Average Min. Temperature (F)	27.0	30.6	34.4	39.6	46.5	53.1	58.9	58.2	50.3	40.8	33.5	28.6	41.8
Average Total Precipitation (in.)	1.23	0.87	1.07	1.22	1.53	1.37	0.61	0.72	0.75	1.01	1.17	1.14	12.69
Average Total SnowFall (in.)	5.7	2.5	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.1	1.7	4.1	15.6
Average Snow Depth (in.)	1	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 100% Min. Temp.: 100% Precipitation: 100% Snowfall: 91% Snow Depth: 90.9%

Average Annual IFR/VFR days

Boise:
300 VFR, 60 IFR
Pocatello:
270 VFR, 90 IFR
Idaho Falls:
268 VFR, 92 IFR
Twin Falls:
295 VFR, 65 IFR
Lewiston:
317 VFR, 43 IFR

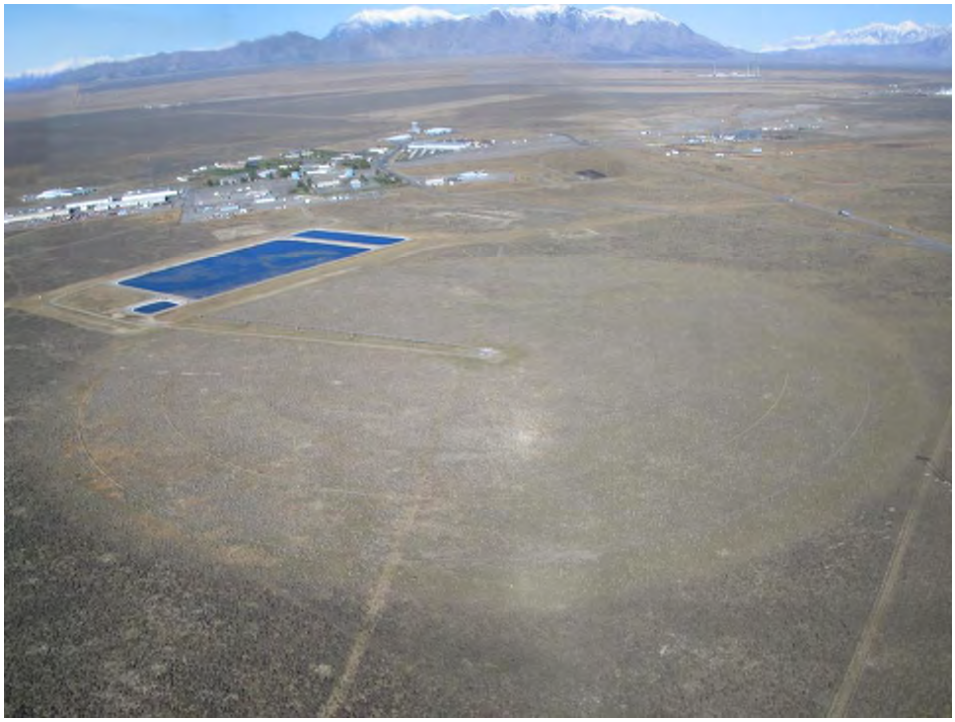
The Idaho Department of Labor provided this list of aerospace parts suppliers. While most companies are not directly working to design or manufacture UAS they represent companies that have the potential to impact a nascent UAS industry. This list should not be considered the sum total of companies that work in engineering and aerospace – there were many companies that are currently unwilling to be listed on a UAS project.

Company	Core Competencies (separate out by commas)	Certifications	Point of Contact (including name and title)	Email: Point of Contact	Phone Number	City	Company Website	NAICS	Employees
Aero Specialities	Ground support equipment	CE Certifed	Brad	brad@aerospecialties	208-378-9888	Boise	www.aerospecialities.com	423860	20-49
Aerocet	pontoons		Linda Headrick	lheadrick@aerocet.com	208-448-0400	Priest River	www.aerocet.com	336413	20-49
Aviation Specialities Unlimited	night vision products,aviation	6 FAA certifications, and many others	Chris Atwood	catwood@asu-nvg.com	208-426-8117	Boise	www.asu-nvg.com	611512	10-19
Conyan Aviation	Maintenance, charter flights	FAA certified maintenance	Brenda Huston	bhuston@conyanaviation.com	208-342-1042	Boise	www.conyanaviation.com	481211	10-19
Custom Coat, McGuire Enterprises	powder coating, heat treating	n/a	Ron McGuire	ccoatron@clearwire.net	208-746-4105	Lewiston		332812	10-19
Cygnus Aero	sheet metal parts and assemblies for aerospace industry		Erin Fogarty	info@cygnusaero.com	208-263-4761	Ponderay	www.cygnusaero.com	332510	100-149
Ende Machine and Foundry	lost foam casting for parts in large machinery				208-305-5435	Craigmont	http://endemachineandfoundry.com/	331511	<10
Gustin Aviation	Airframe maintenance (small, fabric), Powerplant maintenance (radial), avionics sales and installation		Steve Gustin, Owner	sgustin3@msn.com	208-743-1554	Lewiston		488190	10-19
Hillcrest Aviation	General Aviation, Bell Customer Service Facility, Maintenance for Bell 205, 206, 212, 407 and 430 series helicopters, light helicopter airframe repair, Bell Helicopter component overhauls, helicopter and enginer field maintenance, aircraft battery service.	FAA Part 145 Repair Station		lmj@hillcrestaircraft.com	208-746-8271	Lewiston	http://www.hillcrestaircraft.com/	481211	20-49
Horizon Air Industries	Freight, Airline				208-743-9293	Lewiston		481111	10-19
Howell CNC and Machine	CNC Milling, Drilling, & Turning; Grinding & Honing; Welding & Fabrication; Engineering; Reverse Engineering		Tom, CFO	tom@howellmachine.com	208-743-7418	Lewiston	http://www.howellmachine.com	332710	100-149
Idaho Helicopters Inc.	Maintenance,FLIR,	STC	Steve Sandmeyer/Ops Director	steves@helicopters.com	208-344-4361	Boise	www.helicopters.com	481211	10-19
J C Uhling Products (aka MILITEC DEFEN	Welding, CAD/CAM, painting, assembly, CNC milling, CNC turning, CNC press braking, Laser engraving	meets MIL-I-45208 requirements	Jeff Uhling	juhling@jcuhling.com		Cottonwood	www.jcuhling.com	332710	20-49
K & T Steel	Concrete,masonry	ASIC UL listings for fuel starage tanks						332312	20-49
Kitfox	Aircraft Construction- kits		John	john@kitfoxaircraft.com	208-337-5111	Homedale	www.kitfoxaircraft.com	336413	20-49
Lewiston-Nez Perce County Airport	Airport, Air Services, General Aviation, Business Park		Robin Turner, Airport Manager	robinturner@lewiston.com	208-746-4471	Lewiston	http://golws.com	481111	<10
Merlin Systems	UHF/VHF tracking devices, custom RF engineer	None required	Ed Levine	ed@merlin-systems.com	866-742-8475	Boise	www.merli-systems.com	334519	<10
Mountain Aviation Inc.	Private Jet travel,Maintenance	ARG/US platinum,IS-BAO, 10 others	Alex Armijo/ Charter Operations	aarmijo@mountainaviation.com	877-466-3506	Boise	www.mountainaviation.com	481111	<10
Northwest Machine	Machining, milling,assembly	ISO 9001,AS9100	Kerry Wysocki/Eng Mgr	kwysocki@nwmachandmfg.com	208-888-5334	Meridian	www.nwmachandmfg.com	332710	50-99
Precision Machine & Supply, Inc.	Non-destructive Examination, FARO Laser Tracker, Machining, Fabrication, Pneumatic or Hydraulic Cylinder Manufacture & Repair, Pump/Compressor/Blower Rebuilds, QA Inspection	Level II PT, MT, and UT inspectors	Carey Dale, Sales & Tech Team	cdale@precmach.com	208-746-2621	Lewiston	http://www.precision-machine.com	332710	20-49
Quality Machine Products	Quality Machined Parts	AS9100:2009, ISO9001:2008	Rob Doyle/Vice President	rdoyle@qualitymachineparts.com	208-454-2284	Caldwell	www.qualitymachineproducts.com	332710	20-49
Quest Aircraft Company	Design and assemble airplanes		Stephen Zinda	szinda@questaircraft.com	208-263-1111	Sandpoint	www.questaircraft.com	336411	150-199
RPM Machine Inc.			Jim	jim@rpmmachineinc.com	208-442-1999	Nampa	www.rpmmachineinc.com	332710	20-49
Schwabs Screw Machine	CNC turning, CNC vertical machining, CNC wire bender, centerless grinding, sawing, tumbling, multispindle automatic screw machining, hydromat transfer machining	not AS9100 certified	Andrew Glenn, CNC Manager	aglenn@schwabssm.com	208-843-2011 ext. 208	Lapwai	www.schwabsscrewmachine.com	332721	20-49
SP Aircraft	Maintenance,Charter Flights		Andy	sp_aircraft@hotmail.com	208-383-3323	Boise	www.spaircraft.com	481211	<10
Steel West Inc.	Fabricators of structural and misc. steel	ASW D1.1 and ASME	Mike Hoehner-President/Estimator	hoehnere@steelwest.net	208-237-1580	Pocatello	www.steelwest.net	332312	20-49
Stout Flying Service	Flight training, pilot supplies, aircraft rental, aviation fuel, charter flights, crop dusting (aerial application)		Ralph E. Stout, Owner	stoutavia2@lewiston.com	208-743-8408	Lewiston	www.flystout.com	488190	10-19
Teton Creek Manufacturing	CNC machining and Stainless Tig welding		John McNabb/ Owner	jdm6993@yahoo.com	208-201-6624	Rexburg	www.tetoncreekmanufacturing.com	332710	<10
Teton Machine	Machining,Engineering	ISO9001:2008 and FDA	Andy Oyervides/ President	aoyervides@tetonmachine.com	208-642-9344	Payette	www.tetonmachine.com	332721	20-49
Timberline Helicopters	Heavy lift helicopter work, powerline construction, ski towers, forest service	133 & 137	Brian Jorgenson, Owner	stephen@timberlinehelicopters.com	208-263-5987	Sandpoint	www.timberlinehelicopters.com	481219	20-49
Western Air Express	Maintenance,Hazardous&Nuclear Mat. Movers		Sharlene Stredwick	sharlene.stredwick@westernairexpress.com	208-343-2756	Boise	www.westernairexpress.com	481112	20-49
Western Aircraft	Installation,service, repair,NTD avionics	FAA-certified Class 1,2,3 and 4 repair facility	Louie Gavel/Chief Inspector	louieg@westair.com	800-333-3442	Boise	www.westair.com	481219	150-199

Idaho National Laboratory Capabilities

January 16, 2013

In operation since 1949, INL is a science-based, applied engineering national laboratory dedicated to supporting the U.S. Department of Energy's missions in nuclear and energy research, science, and national defense. Most of INL is desert with scrub vegetation and a number of facilities scattered throughout the area; the average elevation of the complex is 5,000 feet (1,500 m) above sea level. The laboratory is located 45 miles west of Idaho Falls, Idaho in a sparsely populated area. A few publicly accessible highways go through the vast INL, but most of the area is restricted to authorized personnel and requires appropriate security clearance.



Idaho National Laboratory

TECHNICAL CAPABILITIES and FACILITIES

Center for Advanced Energy Studies (CAES) - Founded in 2006, the Center for Advanced Energy Studies is a public/private partnership comprised of Boise State University, the University of Idaho, Idaho State University, private industry, and the Idaho National Laboratory. CAES integrates resources, capabilities and expertise to create new research capabilities, expand researcher-to-researcher collaborations, and enhance energy-related educational opportunities. From a broad energy perspective that includes fossil, renewable, alternative energy, environmental stewardship, energy policy studies, and a focus on the role of commercial nuclear power, CAES delivers innovative, cost-effective, credible energy research leading to sustainable technology-based economic development. Major CAES initiatives include advanced materials, nuclear science and engineering, energy policy, carbon management, and bioenergy.

Remote Sensing/GIS – The Geospatial Science and Engineering (GeoSE) team at Idaho National Laboratory leverages cross-cutting capabilities in geographic information systems (GIS), remote sensing, geodesy, 3D visualization, global positioning systems (GPS), and computer science to provide services and capabilities that support decision-makers in a variety of applications, from environmental to civilian, utility, energy, security, and defense.

INL's GeoSE team integrates cutting-edge mathematics, computational science, high-performance computing and predictive analysis with traditional GIScience tools to provide key services and capabilities such as:

- Customized, interactive web- and client-based mapping and database applications designed to help end users visualize relationships, connections, and patterns in spatial data for making better decisions
- Spatial decision support tools and applications which provide a framework for integrating analytical modeling, database management systems, graphical display, tabular reporting, and the decision-maker's expert knowledge

- Digital Photogrammetry
- Image Interpretation
- Lidar Analysis & Modeling
- Point Cloud Analysis and Interpretation
- Sensor integration with airborne vehicles to provide near real-time data for analysis and modeling
- Integrated GIS/GPS field ready data collection and management systems (for both hand held and remote unmanned vehicle data collection)
- Logistics planning to provide decision-makers with optimized solutions for transportation routing or data collection campaigns

Wireless Communications – INL owns and operates an unmatched communications network designed to research and test cellular, mobile and emerging Internet communication protocols and technology. Our wireless engineers operate both fixed and mobile 3-G platforms that allow testing and demonstration within a range of experimental frequencies in a low-background environment. INL is authorized by the NTIA to operate as an experimental radio station enabling local authority and management of frequency on a noninterference basis with local spectrum users.

Fixed Wireless assets at the INL

INL power and cyber engineers are widely recognized for their efforts to improve the security of current and next-generation industrial control systems and component devices. Cyber team members work to develop cutting-edge defensive strategies against exploits, malware and zero-day attacks by analyzing protocols, developing code and reverse engineering.

The U.S. Department of Energy (DOE) recently designated Idaho National Laboratory's (INL) Wireless Test Bed as a National User Facility. Establishing the Wireless Test Bed as a National User Facility will help assert U.S. leadership in full-scale research, development, demonstration and scientific investigation of wireless communications systems.

Control Systems Cyber Security - For nearly a decade, INL has been performing cutting-edge research, conducting vulnerability assessments, developing innovative

technology and providing leadership to increase infrastructure resiliency. With a strong emphasis on industry collaboration and partnership, INL is enhancing electric grid reliability, control systems cybersecurity and physical security systems.

The lab supports cyber security and control systems programs for the departments of Homeland Security, Energy and Defense. INL staff members are frequently asked to provide guidance and leadership to standards organizations, regulatory agencies and national policy committees.

National SCADA Test Bed Program - To ensure the secure, reliable and efficient distribution of power, the Department of Energy jointly established the National Supervisory Control and Data Acquisition (SCADA) Test Bed program at Idaho National Laboratory and Sandia National Laboratory.

The program works to support industry and government efforts to enhance the cyber security of control systems used throughout the electricity, oil, and gas industries.

Working in partnership with the energy sector, the National SCADA Test Bed program seeks to

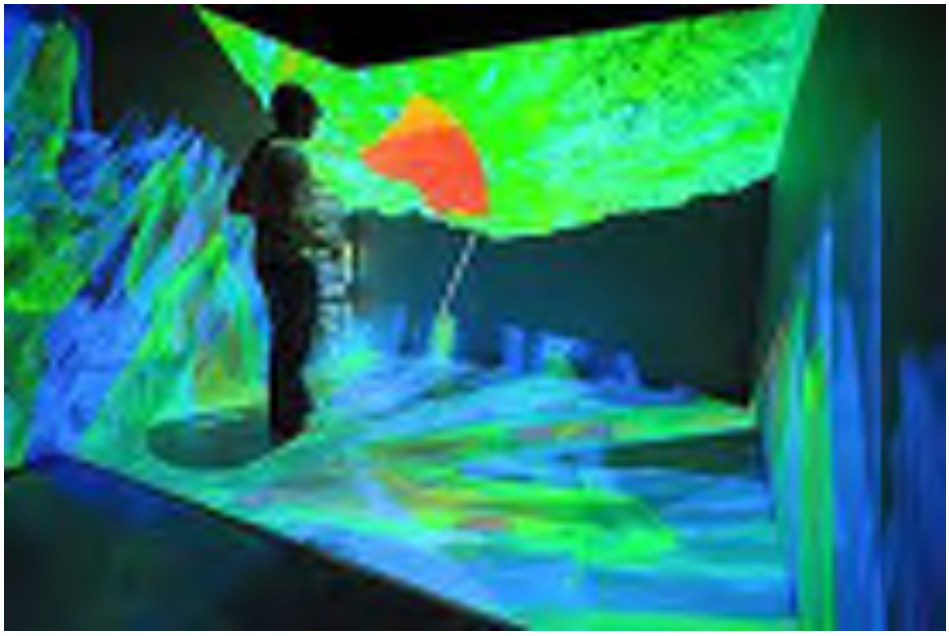
- Assess selected control systems and control system components to identify cyber vulnerabilities. Testing is planned and conducted in collaboration with the interested industry partner and may be performed in the laboratory (test bed) environment or at the partner's site.
- Provide Control System Security training through workshops that describe common cyber vulnerabilities found in control systems and effective methods for mitigation.

- Share with appropriate standard's organizations information that can be used to support the development of improved industry standards applicable to control system security.

Instrumentation, Controls, and Intelligent Systems (ICIS) - ICIS research is centered on developing components, programs, systems and individuals for any application that requires monitoring, control, and human interaction. Research covers five technological areas including:

- Safeguards and control system security
- Sensors
- Intelligent automation
- Human-systems integration
- Robotics and intelligent systems

Advanced Visualization - The CAES laboratory contains a four-walled 3D Computer Assisted Virtual Environment (CAVE) that allows scientists and engineers to literally walk into their data and examine it. It also houses a portable 3-D system designed by staff at Idaho National Laboratory's Center for Advanced Modeling and Simulation (CAMS).



Researchers are "immersed" in their data sets using the INL CAVE

With these systems, researchers can view their data in ways not possible on a traditional 2D computer screen. CAES operates the CAVE as a user facility so that

universities, government agencies and industry can use it to solve various technical problems.

Unmanned Systems – The INL has built a nationally recognized unmanned aerial vehicle (UAV) program through innovative command and control work and successful integration of various sensor technologies. As such, the INL is home to the Department of Energy's Unmanned Aerial Systems (UAS) Center of Excellence. INL has conducted UAS research for almost two decades, has trained and qualified personnel, a UAS airfield, a significant inventory of fixed and rotary wing aircraft and support facilities, a unique geo/meteorological environment, and a broad range of related research and testing capabilities. In the middle of the 890 square miles of high plains desert that comprise the INL is a 1000' paved UAS runway. The FAA, through Certificates of Authorization, has approved the airspace over the INL for flights of ten different UAS platforms.

INL COA approved airspace and UAV airfield.

INL's forty plus UAS platforms are supported my mobile control stations that provide power, communication, monitoring, and data acquisition capabilities. The UAS fleet includes both fixed and rotary wing platforms. The platforms range in size

from less than a pound to approximately 55 pounds. Some platforms are powered using small reciprocating engines others employ electric motors. Commercial autopilots enable full autonomous operation, from take-off to landing, for most of the unmanned vehicles. A number of sensors have been integrated into the airframes to allow information collection and transmission. Sensors that have been developed, tested, and deployed include:

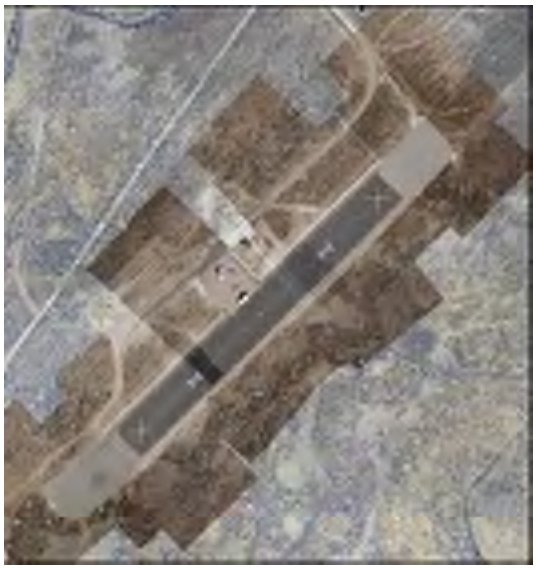
- Standard and high definition video
- Infrared Imagers
- Near-infrared imagers
- Air sampling (collection) devices
- High-resolution still imager (20 Mpixel)
- Multispectral imager
- Wireless network capability to provide real time collection and transmission of large data files

INL UAS fleet includes fixed wing and rotorcraft

A number of research projects developing fundamental control and operation of the UAS as well as integrating sensors onto the UAS are conducted at the test range. Research efforts include:

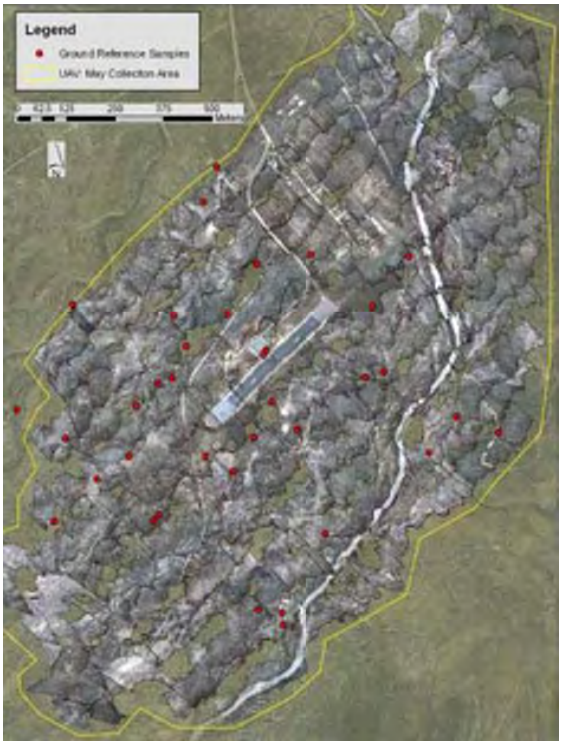
- Collection of high-resolution imagery for environmental monitoring programs

- Collaborating with the Defense Advanced Research Projects Agency (DARPA), the INL's Unmanned Aerial Vehicle (UAV) flight team simultaneously deployed a fleet of small autonomous planes, from a common ground stations, as a proof of concept for fielding multi-agent UAVs to broaden missions in ad-hoc self-healing mobile network communications. The flights demonstrated that UAVs could replace manned aircraft in situations not suited for a pilot. Additional testing was performed to explore UAV range, payloads, communications, mission operations and the integration of intelligent features.
- Site security monitoring of the INL facility
- Development of a small unmanned aerial vehicle (UAV) based system for rapid, accurate, and safe collection of ultra high-resolution geographically referenced aerial imagery. Utilizing a 16 mega pixel camera, ultra high-resolution images are captured and in near real-time wirelessly streamed to a ground based operating interface where each image is automatically mosaiced into a single geo-referenced map.



Example of geo-referenced map created by stitching together images captured by the UAS.

- Development and deployment of a hyperspectral imager to rapidly "read" the health of the environment on a much larger scale than is practical with ground-based sensors. INL researchers have made airborne hyperspectral sensor technology significantly cheaper and easier to deploy on demand.



- Development support and independent validation and verification of Common Data Link terminal for the US Marine Corps

Human Factors - INL researchers have studied and developed innovative and more intuitive ways for operators to utilize machinery and control systems for more than 25 years. Preventing mishaps and accidents requires the application of knowledge of humans in system design to advance the art of technological systems. This requires a thorough understanding of human behavior, equipment functions and failures, and past events. INL's approach has been to develop technology for humans rather than trying to mold humans to technology. The human factors group has extensive laboratory capability where it can conduct human-centered simulation research for the development, demonstration, and deployment activities designed to improve the performance, safety, and resilience of systems and people in complex and high-risk environments.

Advanced Vehicle Testing - INL's Advanced Vehicle Testing Activity gathers information from more than 4000 plug-in-hybrid vehicles. These vehicles, operated by a wide swath of companies, local and state governments, advocacy groups, and others are located all across the United States, Canada and even Finland. Together, they've logged a combined 1.5 million miles worth of data that is analyzed by specialists at INL.

Dozens of other types of vehicles, like hydrogen-fueled and pure electric cars, are also tested at INL. This data will help evaluate the performance and other factors that will be critical to widespread adoption of plug-in or other alternative vehicles.

OUTREACH

Scholarships and Grants - INL supports science, technology, engineering and math (STEM) education in classrooms across the state. Each year, the lab invests nearly $500,000 in Idaho teachers and students. Funding goes toward scholarship programs for high school graduates, technical college students and teachers who

want to integrate more hands-on science activities into their lessons. INL also provides thousands of dollars worth of classroom grants to teachers seeking to upgrade their science equipment or lab infrastructure.

Internships - The lab hires more than 200 interns each summer to work alongside laboratory employees. INL is listed by Vault, the online job resource site, as one of the best places in the U.S. to get an internship. Internships are offered to high school, undergraduate, graduate and post-graduate students in applicable fields including science, engineering, math, chemistry, business, communication and other fields.

Small Business Outreach - In addition to subcontracting more than $100 million worth of work from Idaho's small businesses, INL technologies are often licensed to new or existing companies for commercialization. In the past 10 years, INL has negotiated roughly 500 technology licenses. INL technology has spawned more than 40 start-up companies since 1995.

Small businesses that contract with the lab can participate in a Department of Energy program designed to enhance their capabilities. INL has worked with a variety of small businesses in this mentoring capacity, including International Management Solutions and Portage Environmental.

15 March 2013

Idaho Power Company
Unmanned Aircraft System Inventory

Background

Idaho Power Company (IPC) participates in a cooperative effort to monitor the health and status of the population of Snake River fall Chinook salmon. This population of fish is protected under the auspices of the Endangered Species Act (ESA), and is presently listed as threatened. Each fall biologists from several agencies and tribal groups conduct nesting surveys of these fish (and other similar species/stocks), and those surveys are typically conducted by using a helicopter or fixed-wing aircraft. In November, 1999, a helicopter carrying two biologists from the Nez Perce Tribe crashed on the Clearwater River while conducting a salmon nesting survey; while injuries were sustained by all on board, there were no fatalities. In August, 2010, a helicopter carrying two biologists from the Idaho Department of Fish and Game crashed on the Clearwater River while conducting a salmon nesting survey, resulting in the fatalities of all on board. These accidents led biologists and managers from the IPC to initiate a program to explore the utility of a small unmanned aircraft system (sUAS) that could be used to help facilitate the collection of fisheries data used by regional biologists for the monitoring of this, and other similar, species of salmon. Regional cooperators support this effort.

In late 2010 the IPC purchased two microkopters/hexacopters (Figures 1 and 2), and ground support equipment, from a small company in Montana. A demonstration of the capabilities of these sUAS made it clear that they could perform the type of mission that was required for our data collection. These units are easy to fly and control, have auto-stabilization, are very robust, have a suite of fail-safe safety features, and have characteristics that make them ideal for the type of missions that we expect to use them for.

Idaho Power Company has dedicated a team of two biologists to maintain these sUAS, and to perform any necessary missions. After several in-house demonstrations and consultations, it has become obvious that the use of a sUAS can provide data used in many aspects of compliance with mandated federal license articles tied to our various hydroelectric projects, ranging from vegetation surveys, archeological surveys and cataloguing, avian surveys, mammal surveys, recreation site surveys, to small area mapping and monitoring. Managers at IPC are committed to enabling our crew to obtain all necessary training to maintain a safe working environment and program.

1221 W. Idaho St. (83702)
P.O. Box 70
Boise, ID 83707

MikroKopter/Hexakopter Technical Specifications

Type of craft:	Rotorcraft
Number of rotors:	Six (6)
Motors:	Robbe Roxxy2728-35 brushless
Construction materials:	Main body – plastic/aluminum Booms – aluminum Landing legs - aluminum
Power source:	6200 mAh LiPo battery
Average flight time:	15 minutes
Maximum flight time:	22 minutes
Vehicle height:	0.3 meter
Vehicle diameter:	0.7 meter
Vehicle weight (without payload):	1150 grams
Typical payload:	GoPro video camera (150 grams)
Vehicle weight (with payload):	1300 grams
Radio controller:	Spektrum JR, 2.4 GHz
Typical flight altitude:	20 – 100 meters
Typical flight speed:	5 – 30 km/hr

Available functions:

1. GPS enabled
2. Position hold (stationary hover)
3. Return home
4. Altitude set
5. Programmable waypoint flight – limited number (32) and distance (500 meters radius) from "home position"
6. Wireless, live video

Fail-safe functions

Each of the IPC mikrokopter/hexacopters has a series of redundant loss-link fail-safe features. In the event that a loss-link event occurs, the following occur, in the order listed:

1. A redundant satellite receiver takes over and re-establishes contact with the ground radio controller. Each sUAS has a set of four (4) redundant satellite receivers.

2. If contact with the sUAS is not re-established, and the sUAS has GPS enabled, the sUAS remains at its set elevation, immediately returns to its "home" position, hovers at the set elevation for a pre-programmed amount of time, and finally reduces power so as to descend.

3. If the satellite receivers do not re-establish contact, and the UAS does not have GPS enabled, it will immediately stop and hover at its set elevation, and after a pre-programmed amount of time it will then reduce power so as to descend.

Operations

Our operators/crew take time each month to practice flying set patterns (manually), testing the altitude-set, position-hold, return-home, and waypoint flying functions, as well as performing loss-link procedures under controlled conditions. For purposes of our fall Chinook redd surveys, typical operations occur at discrete, remote, isolated, spawning grounds within the Hells Canyon Reach of the Snake River (Figure 3). Operation altitude is typically kept below 50 meters agl, and within 500 meters of our operators/observers (clear line of sight). Prior to each flight the crew performs a pre-flight check to assess the condition of the rotor blades, the general condition of the booms, fuselage and landing legs, the overall balance of the craft, the operation of the camera gimbal mount, the health of the GPS signal, the battery strength, and the functionality of the power/roll/pitch/yaw controllers. The crew also maintains a detailed flight log book that includes the following:

1. Date of flight
2. Location of flight
3. Craft being flown (IPC has two different hexakopters)
4. Pilot for flight
5. Observer for flight
6. Which battery is being used (each different battery has a specific identification code)
7. Battery start voltage
8. Battery end voltage
9. Maximum altitude
10. Total flight time
11. If the "low battery signal" came on at any time during the flight
12. Pertinent notes concerning the flight
13. If any maintenance was performed on the craft

In relation to flight logs, each craft also has a micro-SD disc installed into the navigation control board that records many aspects of the flight at half second intervals, including (but not limited to): poti inputs, elevation (agl), latitude/longitude, speed over ground, battery voltage, bearing, heading, etc.

Female fall Chinook salmon construct redds in the river bottom by fanning the gravels with their tails and bodies, creating a large depression (pit). Just downstream of that depression a mound (tailspill) is created, as she deposits eggs and then pushes gravels into and out of the pit. These structures are typically oval in shape, can be quite large (up to 10 m long by 8 m wide), and show as light colored patches against the typically darker river gravels (Figure 4). As the population of these ESA listed fish has grown, the number of redds has also increased. In early years it was an easy task for biologists to maintain clear records of as few as 45 redds in a single season. However, current redd numbers can be as high as 2,000 during any one season, and maintaining accurate counts and records of these spawning activities has become a daunting task. The ability of a sUAS to hover over the spawning grounds and collect clear, geo-rectified images has proven to be an invaluable tool for keeping accurate records of redd numbers, and for learning about the

progression and placement of redds throughout the season. Our success of testing a sUAS for these purposes, during the fall of 2011 and 2012, have been so well accepted among our peers and colleagues, that many state and federal agencies, as well as tribal entities, are beginning to see the sUAS as a viable tool for similar applications throughout the Pacific Northwest.

Figure 1. Top view of the IPC sUAS (micrkopter/hexacopter). The red boom-arm indicates the "front" of the craft. It is also possible to see all four redundant satellite receivers, each one near the top of the landing legs. The ruler is one meter in length.

Figure 2. Oblique view of the IPC sUAS (mikrokopter/hexacopter), with the camera mount gimbal and GoPro video camera onboard as payload. The ruler is one meter in length.

Figure 3. Typical operations area for the IPC fall Chinook redd survey project.

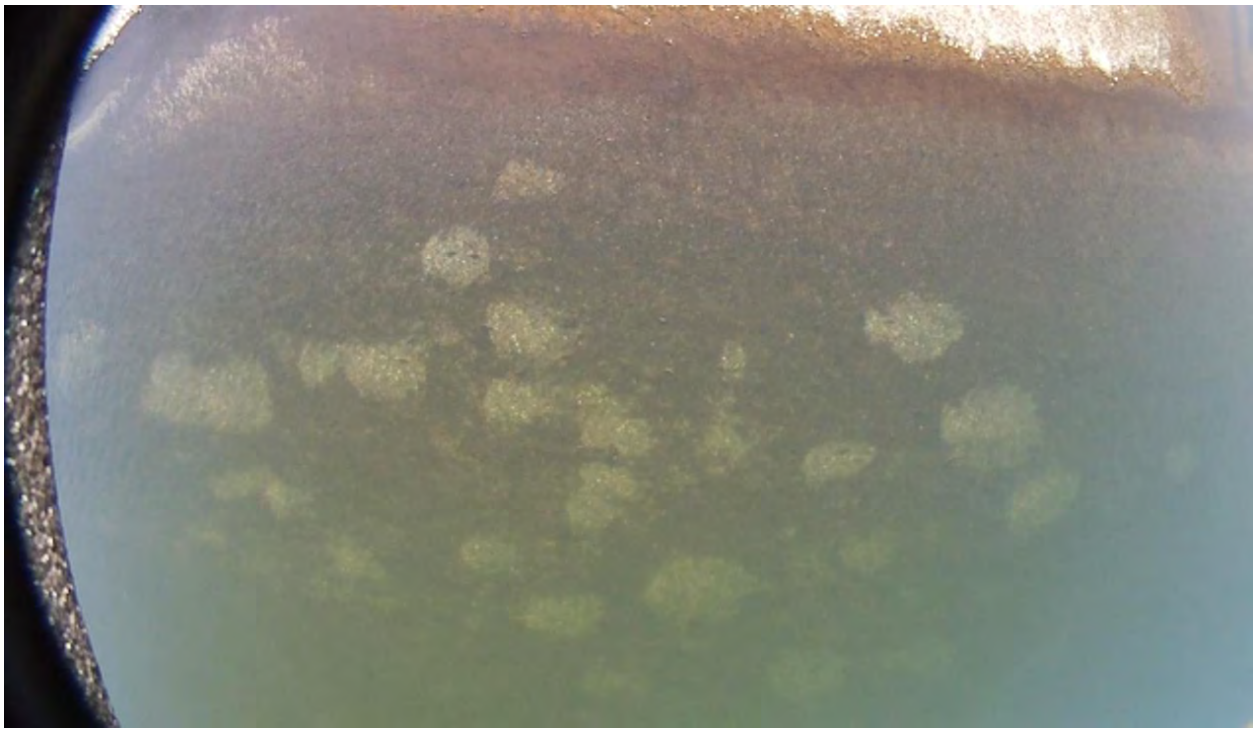


Figure 4. Example of the visual product provided from the IPC sUAS. The fall Chinook redds appear as lighter colored patches against the normally dark river gravels. In this particular image there are 33 redds visible, in various stages of completion and age. Two particularly important aspects of this type of data collection are the ability to track the progression of redd construction and fading through the season, and for accounting for redd superimposition (when redds are built in very close proximity, or on top of each other).

Empire Airlines is an Idaho based corporation, employing over 320 employees and has been in operation since 1977. Empire operates in 15 states and provides a multitude of aviation services including: airline operations - both cargo and passenger service for large international customers; heavy maintenance services - primarily on large turboprops; a wide range of government contract work; consulting services - primarily related to airline startups and equipment changes, STC's etc.

- Empire is a **FAR Part 121 Operator** and **Part 135 Cargo Operator**
- Empire operates a fleet of 52 turboprop aircraft for FedEx
    - 36 Cessna Caravans (C208's)
    - 17 ATR-42/72's
- Empire has operated over 650,000 revenue service flights for FedEx since 1988
- Empire operated a commuter airline from 1984 to 1995.
- A recent agreement with Hawaiian Air will start passenger services again.
- Empire operates a **FAR Part 145 Repair Station (MRO) d.b.a. Empire Aerospace**
- Empire Aerospace operates a 54,000 square foot hangar at CDA Airport
- Empire Aerospace has significant high tech back shop specialties which include: structures, composites, avionics, NDT, refurbishments, etc.
- Empire has performed hundreds of modifications and heavy checks.
- Provide primary heavy check services for Horizon Air (of Alaska Air group)
- Government-related work has been performed for companies such as L-3 communications; Northrup Grumman, SAIC, etc.
- Previous government contract work for USFS, EPA, DOD in projects as varied as cloud seeding in Libya, fire patrol and smoke jumpers, flight instruction, transport of Special Forces to Granada Conflict, monitoring of whales and other mammals and birds in the Arctic, etc.

ADAVSO
ADVANCED AVIATION SOLUTIONS

Advanced Aviation Solutions, LLC, is an Idaho company actively working to bring unmanned aviation solutions to the state. The company brings a wealth of experience in manned and unmanned aviation which will serve as the aviation and technical backbone of any UAS endeavor.

Aviation Experience: Over 20,000 hours employing aircraft in flight instruction, global air cargo, commercial airline, search and rescue, air-to-air combat, long range surveillance, and test and evaluation.

FAA Type Ratings and Military Equivalents:

Light civil aviation: Diamond DA20; Cessna 150, 152, 172, 182; Lear 20, 30, 55; Beech 400
Heavy civil aviation: Boeing 737, 757, 767, 777; Airbus 319, 320
Light military: T-1, T-6, T-37, T-38, AT-38
Military fighters: F-4D/E/G, F-117
Military transport: C-5 A/B/C, C-17, C-21, C-130E
Military helicopter: UH-1H/N
UAS: YRQ-4, EQ-4B, RQ-4 Block 10/20/30, BAMS-D

FAA Aeronautical Ratings: All classes of FAA Commercial and Instrument Pilot (Single, Multi, Rotorcraft), Airline Transport Pilot, Flight Engineer Rating (DC-10), Control Tower Operator, Air Traffic Control Specialist, Radiotelephone Operator Permit

Education/Experience Outside the Cockpit: Department of Defense Acquisitions trained, USAF Mobility Scheduling Course, USAF Test Team Course, USAF Project Manager's Course, USAF Safety investigation Board President Course, USAF Advanced Instrument School, USAF Classroom Instructor Course, multiple MBAs, human factors engineering, computer science, aeronautical science, and adult education

Advanced Aviation Solutions stands ready to help with any aviation project. With our experience in and out of the cockpit we would like to put our expertise to work for you.