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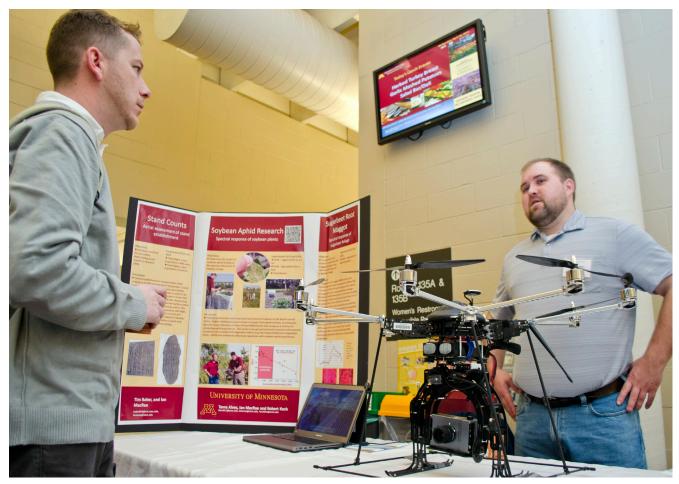
Proceedings:

Preparing for Unmanned Aircraft Systems in Minnesota

Researchers at the University of Minnesota, Crookston, exhibited at the forum.

About the Event

More than a decade has passed since the CIA first began flying drones as part of the United States' "war on terror" following the September 11 attacks. Since then, drones have repeatedly made national and international news headlines related to their use for swift and hard-to-anticipate military strikes. In late 2013, Amazon.com CEO Jeff Bezos reported that his company plans to someday use drones as part of its package delivery services, shedding new light on drones' other capabilities far outside the military realm.

With these new and emerging capabilities, some believe the military connotation of the term "drone" is actually a misnomer for what should more accurately be referred to as unmanned aerial vehicles (UAVs). These UAVs are devices capable of flying without human pilots onboard, and instead are controlled by pilots on the ground. Collectively, the components required to support these airborne operations are called unmanned aircraft systems, or UAS.

Where is this rapidly growing industry headed, and what does it mean for the region and for transportation? About 110 state and national experts gathered for a daylong forum April 30 at the University of Minnesota to discuss these issues.

Welcome and Opening Remarks

Cassandra Isackson, Director, Office of Aeronautics,
Minnesota Department of Transportation

Although the concept of unmanned aviation is not new—actually dating back several hundred years B.C. to China—what *is* new is the technology that continues to evolve and enable UAS to be used in applications never before imagined, explained MnDOT's Cassandra Isackson. The emergence of unmanned aircraft regularly taking flight within U.S. national airspace is expected to bring an enormous economic windfall to aviation entrepreneurs and the nation's economy, she continued, adding that the list of potential uses for UAS is rapidly expanding to encompass a broad range of activities from film making, law enforcement, and disaster response to forest fire monitoring, wildlife research, and border patrols.

Proponents of UAS are trying to change the negative perception these systems have as anonymous killing machines or "Big Brother" surveillance tools, while preparing the public for their eventual incorporation into everyday life. "There is so much buzz around UAS today, because the airspace is getting personal," Isackson said.

One major hitch to this potential business boom is that the commercial applications for UAS are growing faster than the ability of the U.S. Department of Transportation's Federal Aviation Administration (FAA) to keep up with the rules and regulations needed to govern their safe integration into the National Airspace System (NAS), Isackson said. "The goal now [for the UAS industry and the FAA] is to work toward finding balance between developing the necessary regulation and addressing privacy and other societal concerns."

Cassandra Isackson

Why UAS? Opportunities and Challenges

Brigadier General Alan Palmer, Director, Center for UAS Research, Education, and Training for the John D. Odegard School of Aerospace Sciences, University of North Dakota, and Retired Commander of the North Dakota Air National Guard

Although Amazon's drone service is still a number of years away from implementation, the idea is not completely far-fetched considering how fast aviation seems to evolve, Brigadier General Alan Palmer said.

Considering the Wright Brothers' first flight at Kitty Hawk in 1903 to the first lunar landing in 1969, "We went from simply learning how to fly to actually putting somebody on the moon pretty quickly," Palmer said. Now in 2014 the discussion is about how unmanned aircraft are going to be used in the Next Generation Air Transportation System (NextGen)." [NextGen is the name given to a new National Airspace System (NAS), due for implementation across the United States in stages between 2012 and 2025.]

According to Palmer, the use of unmanned aircraft is predicted to impact aviation as dramatically as did the advent of jet engines, which allowed planes to fly higher and faster. "That helped create a global aviation industry that plays a pivotal role in driving today's global economy," he said. "Now we think nothing of getting on an airplane and flying halfway around the world…There is a lot of money to be made [in the UAS industry], and the pie is big enough for a lot of people to share in."

Supporters of the UAS industry say that within a few years these systems could pump $13 billion into the U.S. economy. These experts forecast the creation of more than 70,000 new jobs—with more than 30,000 of those in manufacturing—just over the horizon.

The UAS economy is already booming abroad, Palmer explained, and the United States is a little behind. "This is not the place we want to be," he said. "The U.S. has always been the leader in aerospace, and we want to maintain this leadership role in the UAS industry."

The greatest challenge in the United States for the UAS industry is integrating these unmanned aircraft into the NAS. Unmanned commercial aircraft are currently banned from U.S. skies, but that ban is due to be lifted under legislation that requires the FAA to develop rules allowing them.

In November 2013, as part of the FAA Modernization and Reform Act of 2012, the FAA released its *Roadmap for Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS)*, which outlines the efforts needed to safely integrate unmanned aircraft systems into the nation's airspace by 2015.

The Modernization and Reform legislation also directed the FAA to establish a test site program to develop research

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—Gen. Alan Palmer

General Alan Palmer

findings and operational experiences to further guide UAS integration. In December 2013, the FAA announced its selection of six test site operators: the University of Alaska, the State of Nevada, New York's Griffiss International Airport, the North Dakota Department of Commerce, Texas A&M University–Corpus Christi, and Virginia Polytechnic Institute and State University (Virginia Tech). These test site operators will collaborate with the FAA and industry partners to help develop equipment, systems, rules, and procedures without negatively impacting existing general or commercial aviation.

In April 2014, the North Dakota site was the first to be granted an FAA Certificate of Waiver or Authorization (COA) to begin using a Draganflyer X4ES small UAS at its Northern Plains Unmanned Aircraft Systems Test Site in Carrington, North Dakota. A COA is an authorization issued by the FAA's Air Traffic Organization to a public operator, and it's required to conduct specific unmanned aircraft activity.

Palmer explained that the initial goal of the North Dakota test site is to demonstrate that UAS can be used to check soil quality and crop status in support of North Dakota State University/Extension Service precision agriculture research studies. While supporting the precision agriculture project, the Northern Plains Unmanned Aircraft Systems Test Site also will collect safety-related operational data needed for UAS airspace integration. The information will help the FAA analyze current processes for establishing small UAS airworthiness and system maturity. Maintenance data collected during site operations will support a prototype database for UAS maintenance and repair.

Because the FAA is not providing funds to the test sites, the state of North Dakota is funding its program with $1 million to hire a test site director and begin the stand-up process, then $2 million per year for two years to operate the test site, which will be operational until February 2017, Palmer said.

What are UAS?

Introduction:
  Kevin McKinnon, Executive Director, Economic Development, Minnesota Department of Employment and Economic Development

Speaker:
  Mike Davin, Communications Chair, Twin Cities Chapter of the Association for Unmanned Vehicle Systems International

The Association for Unmanned Vehicle Systems International (AUVSI) is the world's largest nonprofit trade association devoted exclusively to unmanned systems and robotics. The association originally formed following the use of piloted drones in Vietnam, Mike Davin said. Although it developed from military applications, today the AUVSI is getting more involved in the commercial use of UAS. Much of what the organization does is advocate, on behalf of its industry partners, for the interests of the entire unmanned systems and robotics community with members of Congress, the FAA, and other stakeholders.

> "Every year that airspace integration is delayed will cost the U.S. more than $10 billion in lost potential economic impact."
>
> —Mike Davin

In March 2013, the AUVSI released its oft-cited *Economic Impact of Unmanned Aircraft Systems Integration in the United States* report. According to the report, the UAS global market is currently $11.3 billion and is expected to quickly grow over the next 10 years to $140 billion. The economic impact of UAS integration into the National Airspace System (NAS) will total more than $13.6 billion in the first three years and will grow sustainably for the foreseeable future, culminating in more than $82.1 billion between 2015 and 2025.

In Minnesota alone, Davin reported, this integration is projected to lead to more than $142 million and 730 jobs in the first three years, growing to more than $853 million and 1,078 jobs thereafter. "Because the potential economic impact is so great, the AUVSI is pushing for this national airspace integration and working to ensure there's no delay from the proposed 2015 integration date," he said. "Every year that airspace integration is delayed will cost the U.S. more than $10 billion in lost potential economic impact. This translates to $27 million per day."

One of the first industries likely to be commercialized and able to put unmanned aircraft systems into widespread use, Davin said, is precision agriculture, which totals approximately 80 percent of the potential commercial market for UAS. Precision ag drones will be used for such things as drought management, disease detection, watering, and application of pesticide and herbicide, he noted, adding that these agriculture practices are already widely and effectively used in Japan.

Much of the legislative action around the use of UAS in the United States, Davin said, has been in the form of anti-drone legislation related to privacy concerns. As such, he cautioned against losing sight of the fact that this technology can be incredibly useful and valuable. AUVSI recognizes that privacy is a significant issue. "But our point of view is that UAVs do not contain magical cameras that see through walls…and there are some privacy laws already on the books that apply to UAS. We think stakeholders can work together to advance UAS technology while protecting Americans' safety as well as their rights," he said.

Panel Discussion: UAS Education and Outreach

Moderator:
Mike Davin, Communications Chair, Twin Cities Chapter of the Association for Unmanned Vehicle Systems International

Panelists:
Curtis Zoller, Associate Dean of Aerospace Programs, Northland Community & Technical College
Eric Euteneuer, Honeywell Advanced Technology

The potential of unmanned aircraft systems is exciting for everyone involved, moderator Mike Davin declared. The fast pace of change brings with it a variety of challenges. In this session, panelists discussed some of these issues from two different perspectives.

Curtis Zoller said that a significant part of Northland Community & Technical College's efforts "are far outside the mandate of a two-year higher education institution." Because so little is known about UAS among decision makers and authorities around the state, the college spends much time educating its cohorts and others on what UAS is and how it can be utilized as an asset, he said.

In addition to these outreach efforts, Zoller said that Northland also is attracting publicity on its Unmanned Aerial Systems Maintenance Technician training program and its leading-edge and rigorous coursework. The college receives inquiries from countries all over the world and from other states and higher-education institutions related to integrating UAS and other NextGen technologies, he said.

An issue that could negatively affect the entire UAS industry is that the educational system is not moving fast enough to train all of the individuals who will—very soon—need to know how to safely operate UAS technology, Zoller said. "We can't wait for UAS to become fully integrated and become a problem before we move in the direction of getting everyone up to speed."

Since the UAS world moves quickly, Northland has established partnerships with industry and other entities to try to keep up with the latest innovations. "We use our industry

partnerships to incorporate NextGen technology and drive that curriculum into our current training programs. This is one reason we are able to send the highest caliber people out to the industry as a whole," Zoller said.

"So many things [in the UAS industry] are lining up right now, along with the one-of-a-kind [aviation] training programs offered [around the region]," Zoller continued, adding that he believes this is why the Midwest is uniquely suited to answer the industry's needs. "I would much rather see Northland College and our neighbors helping to implement what the [UAS industry] looks like rather than have it be developed someplace else and then imposed on us, because I think we [in the Midwest] can do it better."

For Honeywell engineer Eric Euteneuer, other UAS-related hurdles involve current technical limitations, including the lack both of reliable sense-and-avoid capabilities and command-and-control functions.

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>
> —Curtis Zoller

Sense-and-avoid systems need to give UAS the ability to see and avoid other aircraft and obstacles in the airspace from either onboard the aircraft or from ground-based sources, Euteneuer explained. UAS can take advantage of existing technology, including the Traffic Alert Collision Avoidance System currently used in aviation, but this solves only a small part of the problem for unmanned aircraft, he said. Command-and-control operations depend on reliable and available data links to operate and control the aircraft, Euteneuer continued. The key elements of UAS are the air vehicle itself, the

"We have to look at more policy decisions instead of actual laws that prohibit the use of drones."

—Eric Euteneuer

ground station, and the data link between the two. The reliability of the total system is critical, since the air vehicle is controlled via the data link.

In addition to the technical challenges, Euteneuer believes that moving the UAS industry forward will also require major cultural changes, including society's general acceptance of the use of drones outside of military applications. There are many regulatory challenges to overcome as well in order to integrate UAS safely, he added. "It's more than just standards for the technology, sensors, communications, and sense-and-avoid systems, but also actual rule-making changes that need to occur to enable UAS to fly in our national airspace."

Not all of the regulatory challenges are being left for the FAA to sort out alone, Euteneuer continued. In the United States, the Radio Technical Commission for Aeronautics (RTCA) is responsible for developing standards and consensus among diverse, competing interests on critical aviation modernization issues. The RTCA is used as a kind of federal advisory committee and works in response to requests from the FAA to develop comprehensive, industry-vetted and -endorsed recommendations for the federal government on issues ranging from technical performance standards to operational concepts for air transportation.

The RTCA's European counterpart is the European Organisation for Civil Aviation Equipment (EUROCAE). Additionally, there is an international standards development group called the International Civil Aviation Organization (ICAO). And, Euteneuer said, defense and multi-country activities such as the Mid Air Collision Avoidance System program are developing prototype sense-and-avoid systems and command-and-control systems analogous to some of the work

being done in the United States at the Wright-Patterson Air Force Base's Air Force Research Laboratory in Ohio.

Even with these various organizations in place, Euteneuer said, entities throughout the world are struggling with how to integrate UAS safely, how to write standards that allow new technology to be put on aircraft, and how to take the large avionics boxes down to the size, weight, and power necessary to fly on smaller platforms. Technical and regulatory obstacles exist both in the United States and abroad, "and collaboration so far around the world has been very loose," he said. "The ICAO is probably the closest thing we have to a central standards development entity, but it lags in some ways to what is occurring in both the RTCA and EUROCAE."

In addition to these many and varied challenges, what also troubles Euteneuer are recent attempts in the United States to ban the use of UAVs altogether. "We have to look at more policy decisions instead of actual laws that prohibit the use of drones," he said. That includes considering whether existing privacy laws and policies are sufficient to cover the use of UAS. "I think one of the biggest issues is simply the unknown of UAS and a perceived fear of having drones in our airspace, which has the implication to mean military spying. We will have to work hard to change that perception."

Impacts on Airspace and FAA Roadmap

Moderator:
   Eric Euteneuer, Honeywell Advanced Technology

Speaker:
   Randy Willis, Integration Section Manager, Air Traffic Strategic
      Operations, FAA UAS Integration Office

More than 800 different UAV airframes, of various shapes and sizes, are currently being produced in the United States. "What is the certification path for all of these? That is still a big question," Randy Willis began. Because unmanned aircraft inherently differ from manned aircraft, introducing UAS into the busiest, most complex airspace in the world is proving challenging to the FAA on many fronts, he said.

In 2012, the FAA created the Unmanned Aircraft Systems Integration Office to help facilitate a safe and efficient UAS integration into the National Airspace System (NAS). According to Willis, this new office is developing a comprehensive plan to integrate and establish operational and certification requirements for UAS.

> "[Integrating UAS into the national airspace is] a complex process with many considerations, not the least of which involves privacy concerns."
>
> —Randy Willis

Current FAA rules mostly prohibit commercial drone use, and amateurs are subject to strict guidelines such as no flying above 400 feet, near populated areas, or outside the operator's line of sight. A federal law passed in 2012, however, compels the FAA to allow safe commercial use of unmanned aircraft systems by September 2015.

"The FAA fully understands the economic impact and potential of [the UAS] business," Willis said. Although the agency is working toward policies and procedures that will enable operators to safely integrate UAS into the NAS, "It's a complex process [with] many considerations, not the least of which involves privacy concerns."

Today there two ways to get FAA approval to operate an unmanned aerial vehicle, Willis explained. The private, or civil, sector must obtain an experimental airworthiness certificate to conduct research and development, training, and flight demonstrations. This path also applies to private recreational use of toy and model aircraft. The public, or government, sector must obtain a Certificate of Waiver or Authorization (COA).

According to Willis, in 2007 the FAA received 82 COA applications and approved 52; in 2013 it received 492 applications and approved 423. To date, the FAA has approved only two small UAS models—the Scan Eagle and Aerovironment's Puma—for commercial use, and they are authorized to fly only in the Arctic.

Infrastructure is one major issue with introducing unmanned aircraft into the national airspace, he said, noting that when the existing aviation/navigation infrastructure was built 50 years ago, it did not consider that UAS would ever be a piece of the NAS. Ongoing work is trying to identify the infrastructure changes needed to support the services for UAS.

Although the issue is complex, work is being done to accelerate the regulation and integration of one category, specifically, aircraft under 55 pounds, Willis said. The small UAS rule is a key initiative for the FAA, and currently an overwhelming majority of [COA] applications fall into the small rule category.

Willis said the FAA hopes to issue the Notice of Proposed Rule Making (NPRM) for small UAS by the end of 2014. An NPRM is a public notice issued by law when one of the independent agencies of the United States government wishes to add, remove, or change a rule or regulation as part of the rule-making process. In this case, the small UAS rulemaking would adopt, after a period of time for public comment, specific rules for the operation of small UAS in national airspace. These changes would address their classification, certification of their pilots and visual observers, registration, approval of operations, and operational limits to increase the safety and efficiency of the NAS. The rulemaking would result in regular collection of safety data from the user community and aid the FAA in assessing the effectiveness of regulations to expand small UAS access to the NAS.

Current Applications and Impacts

Moderator:

  Mostafa Kaveh, Associate Dean for Research and Planning, College of Science and Engineering, University of Minnesota

Speakers:

  David Mulla, Professor, Precision Agriculture Center, University of Minnesota

  Weston Merrick, Economic Analyst, Minnesota Department of Employment and Economic Development

  Eric Taipale, FourthWing Sensors

  Ian MacRae, Associate Professor of Entomology, Northwest Research and Outreach Center, University of Minnesota, Crookston

  Dave Gebhardt, Director, Data and Technology, WinField Solutions

To kick off this session, Professor Mostafa Kaveh reported that the University of Minnesota recently launched a new initiative funded by the state of Minnesota called MnDRIVE (Minnesota Discovery, Research and InnoVation Economy). MnDRIVE brings together the strength of University research, education, outreach, and service in a number of key science and technology areas and is focused on advancing Minnesota's economy and positioning the state as a leader in key industries, Kaveh said.

The College of Science and Engineering is leading one of MnDRIVE's focus areas, which relates to robotics, sensors, and advanced manufacturing. "The broad area of robotics and sensors is very relevant to UAS and what we are discussing at this symposium," Kaveh said. Other University of Minnesota researchers are also involved in UAS-related research—specifically, the use of UAS in precision agriculture, he noted.

The agriculture industry is poised to be one of the "sweet spots" for the growing commercial UAS market. Growth in

this area is predicted to move quickly primarily because the ag industry faces many new challenges, Professor David Mulla explained.

Farmers will need to feed and provide energy for an additional 1 billion people in the next 10 years using sustainable approaches, Mulla continued, but little new land is available for what is termed rain-fed crop production. In addition, climate change threatens to alter rainfall patterns and crop yield potential, while agriculture's impacts on water quality and greenhouse gases must be reduced. "We need to feed more people and address environmental issues at the same time," Mulla said. "Given that there is only so much farmable land on the earth, farmers must figure out new ways to be more and more efficient. Precision agriculture is one option."

Conventional agriculture generally involves uniform field management, meaning if a farmer applies fertilizer at an average rate, some spots in the field are over-applied, which contributes to environmental contamination, and some spots are under-applied, which can negatively affect food production. Precision agriculture includes activities such as spectral remote sensing to determine crop health and surgical crop dusting to reduce the cost of chemicals and the runoff of pollutants.

This idea of precision agriculture came about in the 1980s to mean applying "the right management practice, at the right rate, the right time, and right place," Mulla said.

Such practices, however, require a substantial amount of information about the various properties of the field—and this is where spectral remote sensing comes into play.

Different materials reflect and absorb differently at different wavelengths. As such, it is possible to differentiate among

Mostafa Kaveh

materials by their spectral reflectance signatures, Mulla explained. For example, green vegetation has a different spectral signature than brown vegetation or soil, and these spectral differences can be detected by various types of spectral sensors. "We can separate out these different spectral signatures to do our analysis. From that analysis, we can determine what decisions will be made and implemented." For example, users can determine the crop growth stage, color, and leaf status and can look at damage caused by weeds, diseases, and insects.

Multispectral images are the main type of images acquired using remote sensing radiometers. Multispectral remote sensing involves the acquisition of visible, near-infrared, and short-

> ## "The broad area of robotics and sensors is very relevant to UAS."
>
> —Mostafa Kaveh

wave infrared images in several broad wavelength bands. Hyperspectral imaging systems, which acquire images in more than 100 contiguous spectral bands, are also being used.

Various platforms, including satellites, airplanes, and increasingly, UAS, are currently used for remote sensor data collection—and each has its various advantages and disadvantages, Mulla said. "[UAS] can fly when and where you want them, and…provide very high-resolution remote-sensing imagery so we can see the individual features needed to diagnose what is happening. And [they] are relatively inexpensive compared to flying [manned] airplanes."

The main disadvantage to using UAS in precision agriculture

is the difficulty in getting FAA authorization to fly, Mulla said. "Currently, Canada has fewer restrictions, and commercial businesses there have much more flexibility than in the U.S. to use UAS for precision agriculture." Another disadvantage includes the aircrafts' relatively light payload capabilities, which limit the sophistication of the cameras they can carry and the spectral bands that can be detected. Additionally, today's UAVs tend to have a short battery life (in some cases, only 15 minutes).

Moving forward, Mulla predicted that partnerships will be the key to overcoming many of these disadvantages. "There is a wide range of experience represented [at the symposium], and it's obvious that what really will make this work are partnerships between the University, the engineers, and the businesses. Ultimately, I think [the use of UAS for precision agriculture] will benefit the farmers and our food production, our environment, and the public. If we all work together, I think we will come up with a better package."

Professor Ian MacRae explained that his work over the past 14 years has involved studying the targeted application of insecticides—that is, precision agriculture for insect management. He explained that certain plant stressors—insects, weeds, and disease—affect chlorophyll production in the leaves. This makes it possible to detect, using near-infrared reflection, whether plants have increased stress from one of these factors.

When UAS technologies came along, the U of M researchers started to explore using them as a platform for remote sensing. "It was clear that by using UAS, we could get data faster and in a finer resolution than from other platforms like satellite and other aerial imagery. We don't have to wait for a satellite to pass [by] or to schedule an airplane to fly over a field," MacRae said. "And by using UAS, we have an opportunity to get centimeter resolution very rapidly that can in turn be used

David Mulla

to quickly and accurately target what stressors are occurring. This has some real economic and environmental benefits."

Working with a small eight-rotor helicopter, researchers at the Crookston Research and Outreach Center are studying the use of multispectral, hyperspectral, and some visual spectrum sensors to detect insect populations in fields. "We are involved in developing spectral signatures for particular insects and looking at ways in which to identify the difference between weed, disease, and insect problems," he said. Specific projects are looking at soybean aphid populations and sugar beet root maggot. "Growers and producers are extremely interested in this information, and [it's] a constant topic at commodities meetings."

Next, economic analyst Weston Merrick talked about the potential economic impact the UAS industry could have on the country and, in particular, Minnesota. He echoed the AUVSI's prediction that the marginal increase in economic activity from the integration of UAS into the NAS by 2015 will be about $82 billion over 10 years. "The expectation is that 80 percent of UAS use will be in precision agriculture; that's about $65 billion over a 10-year period," he said.

Minnesota is expected to account for about 1.1 percent of that $82 billion total, which between 2015 and 2025 amounts to $850 million and an average of about 1,000 jobs each year, he continued. "Generally, that [1.1 percent] is a good assumption, but it really under-counts Minnesota, because a lot of our economic impact will be in the UAS payload [technology sector]."

Overall, the payload market represents about 38 percent of the total spending on UAS, Merrick explained. Minnesota's competitive strongholds include computer and electronic product manufacturing, software production, and fabricated metals—things that go into building UAS payload systems and that were not counted in the AUVSI analysis.

Merrick also believes UAS will significantly impact Minnesota because the state is third in the nation in net income from agriculture, behind only California and Iowa. And the fact that Minnesota ranks 14th in the nation in production/manufacturing occupations and 16th nationally in high-tech occupations will mean more employment in the manufacturing sector, Merrick said.

Developing the workforce to handle this increasing workload will be a critical component to the state's economic success in UAS, Merrick continued. Minnesota is fortunate to have a large pool of educated individuals, but high-school-level students need to be better educated about their career paths and the jobs of the future, he declared.

> "I think [the use of UAS for precision agriculture] will benefit the farmers and our food production, our environment, and the public."
>
> —David Mulla

Although the UAS industry is currently experiencing a major upswing, it already has a long history in Minnesota, Eric Taipale next explained. Taipale is the chief technology officer at FourthWing Sensors, a Mankato, Minnesota-based company that designs and manufactures sensor payloads and fully integrated small unmanned aircraft systems for the agriculture, infrastructure monitoring, and public-use markets.

Ian MacRae

Taipale said that during his previous time with Minnesota's Lockheed Martin heritage operations, he and his team built several thousand unmanned aircraft systems that were deployed overseas for almost a decade for various military activities. All of the design and engineering, and much of the production, was done in Minnesota. Now with FourthWing Sensors, Taipale said he's "looking ahead to two years from now when some of the regulatory issues are sorted out...and UAS will be another tool in the arsenal that crop consultants,

> "Growers and producers are extremely interested in this information and [it's] a constant topic at commodities meetings."
>
> —Ian MacRae

individual farmers, and co-ops will use to provide many different sources of information for downstream processing."

As Taipale's team of sensor builders has moved into the precision agriculture market, he says it has been eye-opening to sit down with agronomists. "We are learning about what goes on in a field to make crops grow or not grow and what kinds of measurements the farmers are interested in," he said. "This is helping us figure out how we can deliver on the value of UAS. ...We are just now scratching the surface in terms of how easy these systems are to use and what they can do. I think [the UAS industry] will provide a phenomenal opportunity, certainly as a manufacturer, but also for the state. Our company CEO likes to say that this [UAS] is the biggest thing to happen in agriculture since hybrid seeds came along."

Today's farmers focus a lot on in-season management through plant nutrition, crop protection products, and similar measures, Dave Gebhardt added. "But the future is really about having the right insight tools that help move farmers to data-driven decisions so they can then make good recommendations," he said. "What I see happening more and more is the use of real-time data and real-time analysis, which make those insights a lot better...We're putting more powerful tools in the hands of our agronomists, which ultimately leads to better recommendations."

The biggest challenge has been demonstrating to farmers the value of these more powerful tools and then getting the farmers to pay for them, Gebhardt continued. There is a good deal of hype from companies—UAS and others—promising more than they can deliver. "Technology is evolving fast, and I worry that farmers will rely on their own judgment to model their crops...and make their own recommendations. We need to make sure we have the right engagement on the advisor side so farmers are not making bad decisions. But the jobs won't come, technology won't come, manufacturing won't come, until farmers see the value [of UAS] and are willing to pay for it, and that's where I think we can all work together."

North Carolina Case Study: Establishing UAS in the State

Moderator:
  Todd Colton, FourthWing Sensors

Speaker:
  Thomas Zajkowski, Flight Operations Manager, NextGen Air Transportation Center, Institute for Transportation Research and Education, North Carolina State University

The NextGen Air Transportation (NGAT) Center at the North Carolina State University Institute for Transportation Research and Education is a nonprofit partnership involving academia, industry, and government. The center's mission is to develop and evaluate improvements to existing and anticipated air traffic control, airspace management, airport and airspace system capacity, surface traffic management, and flight safety. Thomas Zajkowski said the center's current focus is on UAS, but it hopes to expand into manned aviation someday. "Overall, we are working to help establish North Carolina as a leader in the future of aviation," he said.

The NGAT Center launched its UAS program in 2012 in efforts to support North Carolina's emerging private UAS industry, Zajkowski continued. He noted that the AUVSI's 2013 economic report (*Economic Impact of Unmanned Aircraft Systems Integration in the United States*) estimates the UAS industry could create almost 1,200 jobs and $600 million in economic activity in North Carolina alone by 2025.

In recognition of this potential economic boon, the North Carolina state legislature approved $2.5 million for NGAT to build UAS test facilities and staff the operation for two years as the program becomes established. NGAT also has received a Certificate of Authorization (COA) from the FAA and state Chief

Information Officer (CIO) approval (required by North Carolina) at three test sites—the Hyde County airport (Gull Rock Site), the North Carolina State University Butner Beef Cattle Farm (Butner Site), and a private airfield in Moyock (Caratoke Site)—where research operations are now being conducted. This test program will focus on education and research, government use cases, and economic development.

As the lead organization for UAS research and testing in North Carolina, the NGAT Center provides information about all current UAS flight activities, including planned flights, data from flights, and flight descriptions (aircraft, sensors, flight times, etc.). In addition, the center is available to all state agencies and local government entities to assist with UAS-related activities, including obtaining COAs and collaborating with vendors to acquire or lease a UAS.

Although nearly all public agencies statewide have expressed

"How do we sort through all of the images and video collected to get what we need?"

—Thomas Zajkowski

Thomas Zajkowski

interest in UAS, Zajkowski explained that the initial push is expected to come from the agriculture and public safety markets. In any case, NGAT's efforts will focus on assessing the safe and responsible integration of UAS technologies by North Carolina's state and local government agencies and on developing a statewide UAS integration strategy. "We want to make sure our public agencies do not just go out and buy any UAS. We want to be sure the UAS platform they purchase is the right one for their mission, which will in turn ensure the proper use of taxpayer dollars," he said.

To this end, Zajkowski explained, a cross-agency, cross-functional working group led by the state CIO's Office, the North Carolina Department of Transportation, and the NGAT Center was established to assess policy, privacy, governance, outreach, and other UAS-related issues as they concern North Carolina. The group—which includes representatives from local government, state agencies, and universities—studied potential uses for unmanned aircraft, as well as safety, citizen privacy, data management, costs, and funding considerations. It then developed recommendations for the use of UAS in North Carolina and proposed the formation of a statewide

governance board to guide the state's adoption of this emerging technology. In March 2014, a report of the group's findings was presented to the Joint Legislative Oversight Committee on Information Technology.

Zajkowski said one issue the working group is studying is data management. "How do we sort through all of the images and video collected to get what we need? How do we index and archive this data? The military is able to look at only 10 percent of the data it collects, and it has a lot of people at its service."

Because North Carolina has a large agricultural industry, NGAT is gearing up many of its research efforts specifically to address UAS and agriculture. Some of NGAT's agriculture-related research includes the use of UAS for aerial surveying and mapping, crop analysis, aerial applications of chemicals, and herd management. "We know that these [UAS] systems have to be easy to use and the analytics behind them have to be done quickly and accurately…There are still a lot of things that have to be figured out for these to be commercially viable systems for farmers," he said.

Where Do We Go From Here? Opportunities and Challenges

Moderator:
  Gina Baas, Associate Director of Engagement and Education, Center for Transportation Studies, University of Minnesota

Panelists:
  Charles Samuelson, President, Minnesota Chapter, American Civil Liberties Union
  Brigadier General Alan Palmer, Director, Center for UAS Research, Education, and Training for the John D. Odegard School of Aerospace Sciences, University of North Dakota, and Retired Commander of the North Dakota Air National Guard
  Thomas Zajkowski, Flight Operations Manager, NextGen Air Transportation Center, Institute for Transportation Research and Education, North Carolina State University
  Curtis Zoller, Associate Dean of Aerospace Programs, Northland Community & Technical College
  Randy Willis, Integration Manager, Air Traffic Strategic Operations, FAA UAS Integration Office

Over the past several years, the American Civil Liberties Union (ACLU) has raised some red flags over the use of drones in U.S. airspace. In a 2011 report, *Protecting Privacy from Aerial Surveillance: Recommendations for Government Use of Drone Aircraft*, the group expressed specific concerns over the potential invasion of privacy. "There are currently no real privacy laws in the United States," Charles Samuelson said, adding that the only privacy protection citizens have results from the U.S. Constitution's Fourth Amendment restrictions on government activities. "Basically, your information is not yours if it is ever shared. The information about you…is now the asset of any number of companies, and it is traded, bought, and sold, with no input from you." One example is Google Map's street view of properties, which is the property of Google, not the property owner.

With regard to unmanned aircraft, Samuelson said, operators should have either the property owner's permission to fly over

their land or the property owner should be compensated. For example, if Farmer A wants his field surveyed to determine the proper chemical application, there's no problem, Samuelson said. However, if the UAS operator flies over Farmer B's field without permission and then sells the data collected to a fertilizer company, "That would be wrong, and someone should be on the hook for it."

In researching ACLU members and others in the community, Samuelson said he has found that people are looking for transparency and accountability. "As we look at UAS technology as a bright, prospective profit source, we have to remember that this profitable business is based in part on information we can acquire without compensating the owners of that information. That business model is not sustainable… because laws change, judges' decisions change…As a cautionary tale at this stage of the game in the UAS industry, it is a good time to think about these privacy issues and how to head off what will be a large discussion over next the 20 years about privacy."

Rather than focus so much on the vehicles themselves, added Thomas Zajkowski, the focus of discussions should be about data. "We can use a UAS [to collect data], but I could tape a

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>
> —Charles Samuelson

Curtis Zoller, Thomas Zajkowski, Randy Willis, Alan Palmer, Charles Samuelson, and Gina Baas

sensor to my Cessna [airplane] and collect data that way, and then a UAS-specific law would not apply," he said. "Instead of talking about how data is collected, the conversation should be about how the data is used and why is it being collected."

Samuelson agreed, but also said society has generally been behind the curve with every technological transition. "Technology changes at an ever-increasing pace, which means we need to be about first principles…If you are in charge of collecting data for a private company or for the government, it is your job to educate people and not just talk about the advantages but talk also about the risks and disadvantages…It seems we have a small window of opportunity now…to start having these conversations, so that when the technology is deployed, people understand it and are not afraid of it," he said.

From an educational standpoint, Curt Zoller said, the aim is to be prepared for UAS technology, and that also includes privacy issues and safety considerations—and preparing a workforce to respond to these issues. "We need a fundamental cultural change that allows us to invest in what we know is coming. If the goal [of UAS] is to provide more efficiencies and safety for aerospace, law enforcement, and other first responders, and better ways to keep our military personnel safe—I say go for it. But we have to be sure to hold those who violate our privacy or our trust responsible and accountable," he said.

Moderator Gina Baas then directed panelists to discuss, from their varied perspectives, what the primary motivations are for Minnesota to invest the time, money, and resources on building an environment for UAS to flourish.

"It's really a business decision," Alan Palmer stated briefly.

"UAS is a growing segment of aviation; it is just another mode of transportation."

"These unmanned systems are opening up new research that has not been done in the past," Thomas Zajkowski added. "I believe that is where the benefit is to all of us: UAS opens up more opportunities."

"I think this UAS integration process will be painful for the first couple of years as we move through this process," Zoller said. "But in the long term it will create a much more sustainable, efficient, safe air space system and will revolutionize the logistics world across the board in this state and elsewhere. What we're talking about today is just the tip of the iceberg."

> "We need a fundamental cultural change that allows us to invest in what we know is coming."
>
> —Curtis Zoller

Randy Willis provided the last remarks, which centered on the FAA's ongoing mission to facilitate the use of UAS in the United States. "We want a safe, efficient, and timely integration [of UAS] into the National Airspace System. And 'safe' is what the FAA does….As we integrate UAS into the airspace, we will do so without eliminating any of the efficiencies already in the system. Commerce would not allow for disruptions, and that is not what the public wants either," he said. "We have some direction from Congress…and we have the resources and people in place to make it happen."

For Further Information

UAS forum presentations: www.airtap.umn.edu/events/workshops
/uasforum/2014/index.html

North Dakota's UAS industry: www.business.nd.gov/aviation

Northern Plains UAS Test Site: www.npuasts.com

NextGen Air Transportation Center: kyle_snyder@ncsu.edu or 919-515-8623