NASA Advisory Council Aeronautics Committee Meeting
August 28, 2018
NASA Ames Research Center
Building 3, North-Wing Room
Moffett Field, CA

Welcome

NASA Advisory Council Aero Committee Chair Mr. John Borghese called the meeting to order and introduced new committee members Mr. Scott Drennan, Mr. Anil Nanduri, Dr. Tom Shih and Dr. Eric Allison, who was not present. After some additional words of welcome and meeting logistics from Dr. Jaiwon Shin, NASA's associate administrator for aeronautics, and Ms. Irma Rodriguez, executive secretary, Mr. Borghese laid out the committee's work plan for the day and explained how today's discussions are meant to potentially result in findings and recommendations – two types of advice the committee provides to the NASA Administrator.

Ames Research Center Overview

As host for this meeting, Dr. Eugene Tu, director of NASA's Ames Research Center, presented a historical overview of NASA's second oldest field center and briefed the committee on some of the current activities taking place at Ames in support of NASA Aeronautics. Originally a fully aviation-minded research center in support of the National Advisory Committee for Aeronautics that will celebrate its 80th anniversary next year, he noted that Ames now has eight core competencies. They include air traffic management, entry systems, advanced computing and IT systems, intelligent adaptive systems, cost effective space missions, aero sciences, astrobiology and life sciences, and space neurosciences.

Dr. Tu highlighted some of the unique research facilities that call Ames home and described the origins and present-day usage of the NASA Research Park, 2,000 acres of real estate that takes advantage of property and buildings when the Moffett Field Naval Air Station – where Ames is physically located – was closed.

Dr. Tu noted how Ames' location in the heart of Silicon Valley has played a role in shaping the center's culture, especially in terms of its approach to innovation and entrepreneurship. He said that these opportunities come with challenges as well, particularly in terms of the high cost of living, congested roads and NASA's ability to compete with area companies in terms of talent and workforce. At the same time, as workers move between government and industry jobs, this leads to a healthy exchange of ideas and builds networks and connections.

At the end of Dr. Tu's remarks, Mr. Borghese asked him if there was anything Ames was doing to enable students to accept internships at the center, given the local high cost of living. Dr. Tu replied that dormitory-like facilities left over from the naval air station were taken over by the center's employee exchange, enabling non-appropriated

funds to be used to operate the facility and provide student housing at dramatically lower costs compared to other area housing.

Aeronautics Research Mission Directorate Strategy Overview

Dr. Shin presented a high-level overview of NASA Aeronautics' current research activities. These activities, he noted, are strategically selected based on input from other government agencies, industry and academia, so that everything NASA Aeronautics does is relevant in addressing the most important areas for advancing the nation's global leadership in aviation.

Dr. Shin highlighted NASA Aeronautics' emphasis on building and utilizing inter-center collaborations, as well as success in the way NASA Aeronautics has worked with other government agencies – specifically working with the Federal Aviation Administration (FAA) through Research Transition Teams to deliver NASA-developed technology to the FAA for eventual operational deployment.

Dr. Shin provided summary updates on NASA's status in the areas of Unmanned Aircraft Systems (UAS) and Urban Air Mobility (UAM), as well as supersonic flight over land – both topics that were discussed in more detail later in this meeting. He also reviewed how the directorate is structured with four programs – three considered mission programs and one a seedling program that provides new ideas to the other three.

Dr. Shin concluded with a review of the positive trend in funding NASA Aeronautics has enjoyed during the past decade, and how that budgetary support is helping to open a new era in aviation. He also warned this is a critical time, as other nations are moving quickly to develop their own advanced aviation capabilities and industries. As a result, the United States must stay vigilant if it doesn't want to be passed by and left watching others from the sideline.

Urban Air Mobility (UAM) Strategy:
UAM Coordination and Assessment Team (UCAT)

Mr. Davis Hackenberg, NASA's strategic advisor for UAM, presented an overview of the agency's current and planned activities related to UAM, beginning with a brief history of the "whirlwind" of activity accomplished since the UCAT was formed in the December 2017 and January 2018 timeframe. He characterized UAM by saying the aviation community has never seen anything like it.

Mr. Hackenberg described how UCAT is organized and some of the roles of its members. He explained how UCAT is an example of a new way of doing business within NASA Aeronautics and of working with the aviation industry, which increasingly is welcoming new companies with little to no prior aviation-related experience. He said UCAT's focus is not just about technology development; it's more about bringing people

together, being a systems-level agency and leveraging lessons learned from UAS-related projects, all in a unified strategy.

A major focus by UCAT this year has been on a pair of UAM market studies NASA commissioned to Crown Consulting and Booz Allen Hamilton. The focus of these studies was to evaluate potential markets and how variables such as policy, regulation, technologies, social barriers and social acceptance might be an influence. Each company chose three specific business cases. One of those business cases was examined by both companies to see if similar results would be obtained.

Although final results of the two market studies are not due until the end of September, Mr. Hackenberg reported it appears most of the business cases could be profitable in the long run. The air ambulance case might be a little trickier, but the value to the public is obvious. He also reminded the committee that, as with all research, you get some answers that only create more questions – a key one in this case being whether all the assumptions are valid.

Mr. Hackenberg also presented a summary of where some of the current major industry players are with their UAS plans, in terms of both reference missions and timing. He commented that many of the stated goals might seem aggressive, but NASA stands ready to help the community any way it can.

Mr. Hackenberg concluded his presentation and discussion on this topic by noting NASA's work on things directly and indirectly related to UAM dating back 20-plus years. That experience is informing NASA's strategic plans, and the data gained from these market studies will ensure NASA remains a leader in helping the industry achieve its goals. This guidance is especially important as new entrants to the market face a learning curve of sorts in working with NASA and other government agencies.

Discussion

Committee members held a lengthy discussion with Mr. Hackenberg about autonomy, human factors (such as pilot training), machine intelligence, systems engineering, other reference missions (such as those with and without passengers), environmental factors, setting regulations, communication standards, certification and costs associated with all of those assumptions. The importance of public-private partnerships and the ability to successfully transfer technology also were discussed at length.

Findings/Recommendations

No findings or recommendations came about as a result of these discussions.

Urban Air Mobility (UAM) Strategy: Grand Challenge

Mr. Hackenberg briefed the committee on NASA's plans for a UAM-related Grand Challenge to be held in 2020. He described the challenge as an opportunity for

participants to demonstrate their ability to execute system-wide safety and integration under a number of different scenarios. By doing this, NASA hopes to better understand and benchmark what the industry (representing both vehicle development and airspace management companies) can do with respect to safety and the available technologies. However, he noted this is not about bringing technologies to showcase. In fact, NASA wants to make the event challenging enough that many participants won't be successful in demonstrating every aspect of the Grand Challenge. In this way, both NASA and industry can learn from each other about what still needs to be done to mature the various UAM concept of operations.

More specifically, the mission and goals of the UAM Grand Challenge were stated as: promote public confidence in UAM safety and facilitate community-wide learning while capturing the public's imagination; ensure UAM community participants address ecosystem-wide safety and integration barriers in a robust and relevant environment; and obtain critical insights into UAM systems via realistic scenarios focused on enabling FAA safety, certification and operational approvals.

Discussion

Dr. Michael Francis asked what Mr. Hackenberg characterized as a very common question at this point in the event's development: How is NASA planning to implement the Grand Challenge and should it be considered a contest of any kind in which a winner is selected?

Mr. Hackenberg noted that many specific details about exactly what the Grand Challenge would look like or how it would operate are still being discussed. However, the idea of awarding prizes or selecting winners in the same vein as centennial challenges or those conducted by the Defense Advanced Research Projects Agency (DARPA) was not in the plans.

Dr. Tom Shih asked to what extent the Grand Challenge would involve and address the need for workforce development in the areas that are unique to UAM operations. Mr. Borghese expanded on the question and asked if the Grand Challenge would include some level of university student involvement.

Mr. Hackenberg replied that university involvement would be welcome. As the Grand Challenge is further developed, there may be areas where universities would have the resources and expertise to contribute. Developing a fully operational and safe UAM ecosystem will require input from many different players that can offer relevant contributions.

Dr. John-Paul Clarke suggested that NASA consider requiring a university partnership with industry for any company wanting to participate in the Grand Challenge. Other committee members echoed this sentiment, noting the ongoing challenge of attracting students to pursue aerospace careers. Mr. Hackenberg agreed with the sentiment of

these comments and said NASA would have conversations about the best way to include university participation in the Grand Challenge.

Mr. Anil Nanduri urged that NASA consider those areas in which industry does not fully have answers and place an emphasis on them in the Grand Challenge. In this way, NASA can provide leadership to industry in helping to address these areas, either by encouraging industry in order to achieve success in a Grand Challenge or by influencing NASA's research portfolio. Mr. Hackenberg agreed.

The committee discussed a number of different topics related to specific parts of UAM operations and how they might be represented in the Grand Challenge. Topics included autonomy, standards, FAA certification, detect-and-avoid, airspace management, aircraft requirements, intellectual property considerations, public engagement and acceptance, use of public and/or private ranges, and how the next Grand Challenge might be shaped by the first one and any resulting industry input.

Findings/Recommendations

The Urban Air Mobility Grand Challenge is a great initiative for NASA to set the leadership beacon on UAM that inspires the industry and the next generation of workforce alike. While it is in the early stage of planning, the Committee believes that the UAM Grand Challenge needs to be articulated more clearly. The Committee also recommends that NASA's role is to study, estimate, and articulate the trade space for UAM. The Committee urges the project to work closely with universities to take advantage of the talent available. The Committee complimented NASA for the evolution of the relationship with the FAA and how this change has improved the level of collaboration.

Unmanned Aircraft Systems (UAS) Update

UAS in the National Airspace System (NAS)

Dr. Ed Waggoner began this portion of the agenda by offering a summary of the intent of the UAS in the NAS project and followed that discussion with an update on the project's latest developments and status. He reviewed the project's goals and how they affect, and are being considered with, the UAS Traffic Management (UTM) project to result in a cohesive, overall UAS research strategy.

Dr. Waggoner reviewed the vision for what a future civil UAS airspace environment might look like, noting the different types and sizes of aircraft that could be flown, the various types of airspace these vehicles could be flown in (high or low altitude, rural or urban), and the various technological and regulatory enablers required for safely managing air traffic. He followed this with a review of how NASA's efforts to support the development of minimum operational performance standards for the FAA have been divided into two phases, which are based on the type of aircraft and class of airspace

involved. In updating activities performed related to each phase, Dr. Waggoner underscored the importance of ensuring the FAA is receiving the information it needs as data is gathered, so it can more efficiently develop necessary rules and regulations in support of UAS in the NAS operations.

As a recent example of progress made, Dr. Waggoner highlighted the successful completion of achieving the first-ever certification of authorization and subsequent execution of an unmanned aircraft flying through the national airspace system without a chase aircraft. He noted some of the complexities that had to be overcome and characterized the accomplishment as a graduation of sorts from the first phase of the UAS in the NAS project. He also underscored the importance of the working relationship with the FAA and how it was strengthened by this feat.

Looking ahead, Dr. Waggoner explained that NASA is moving toward a systems integration and operationalization demonstration in partnership with industry. The idea is that working with industry partners – three have been identified and are working toward signing agreements – NASA will explore ways to develop and integrate critical technologies (such as command and control, detect and avoid) onto an unmanned aircraft and work towards type certification, all while working with the FAA to ensure appropriate approvals and policies are identified that will benefit the entire industry.

Discussion

The committee and Dr. Waggoner together discussed a number of specific details regarding UAS in the NAS requirements and technologies and considered a variety of both routine and contingency scenarios under which future unmanned aircraft of various types and capabilities might operate. No specific conclusions or recommendations from the committee to NASA arose from this discussion.

Findings/Recommendations

No findings or recommendations came about as a result of these discussions.

UAS Traffic Management (UTM)

Mr. Akbar Sultan continued this portion of the agenda with an update on UTM, setting the stage by noting how UTM operations are expected to compare to what is now flying in the national airspace. This difference is significant in that currently in the NAS, there are between 50,000 and 60,000 operations each day, but with the way smaller UAS are expected to operate, there could be millions of daily operations requiring some kind of air traffic management engagement. This paradigm shift is at the heart of a research pivot NASA Aeronautics is making to transform its research activities as well as the aviation community.

A key feature of what UTM is helping to enable, and, therefore, the focus of NASA-led research activities, is an operational architecture in which third-party service providers

will work with operators to manage the low-level airspace in a manner that is acceptable and certifiable by the FAA. Key technologies, as discussed before, include command and control, weather knowledge, terrain knowledge and detect and avoid. Mr. Sultan noted the accomplishments of the three technology capability levels (TCL) in which increasingly complex UTM operations were demonstrated at FAA test sites around the country. This now sets the stage for TCL4, which will be the most complex test involving a simulated dense urban environment to date.

Discussion

Mr. Borghese asked how UTM is different from the current Low Altitude Authorization and Notification Capability (LAANC), which the FAA has established to approve requests for UAS operations in various classes of airspace. Mr. Sultan explained that UTM will take LAANC a step further by involving multiple vehicles operating within a larger volume of airspace. He noted that LAANC was a direct result of UTM-related collaboration between NASA and the FAA.

Dr. Clarke initiated a brief discussion about the use of batteries, asking if there was a requirement within the TCL activities for recording the history of the environmental conditions in which batteries powered UAS aircraft. He also asked what considerations were made for dealing with flight durations driven by battery performance and how UTM might handle engine-out situations in which the aircraft's batteries expire. Mr. Sultan replied that such considerations were not part of TCL, but they are within the UTM project to some extent, and also are being addressed within the System-Wide Safety Project.

Several committee members asked how TCL4 relates to the Grand Challenge and how complex it can be in simulated dense urban environments. Mr. Sultan said the two are not identical, but they are coordinated. Both are in planning stages. As already noted, both will deal with dense urban environments that are simulated because these tests cannot take place over Manhattan, for example. He said that, in a sense, TCL4 will enable the Grand Challenge. These statements led to a lengthy discussion among the committee about dealing with specific variables within the simulated environment, including wind effects, Wi-Fi latency, loss of control and other contingency scenarios. Mr. Sultan summarized NASA's view that "we don't need to have a test site where you actually have a lot of people, animals, other infrastructure and buildings and everything else. It's more of determining if you were operating at a dense urban environment, what are all your constraints that you have to operate in? What are all the safety measures that you have to have on the vehicle, what are all the mitigation steps that you need to have on the vehicle?"

Speaking on behalf of the committee, Mr. Borghese concluded the discussion by praising NASA for its pioneering work on developing a UTM capability and its leadership in building interest and excitement within industry and the FAA. NASA's efforts now to transition the new technology and its own research portfolio to meet the needs of industry are truly outstanding, he said.

Findings/Recommendations

No findings or recommendations came about as a result of these discussions.

Low Boom Flight Demonstrator (LBFD) Update

Dr. Ed Waggoner summarized the history that led to the establishment of the Low Boom Flight Demonstrator project, reviewed the major goals of the project and its associated timeline, and provided the committee with a progress report.

The goal is to provide the FAA and the International Civil Aviation Organization (ICAO) with a statistically valid set of data regarding public reaction to noise generated by the X-59 QueSST as it flies at supersonic speeds over selected U.S. communities. Dr. Waggoner noted recent related research highlights and mission milestones. These included the awarding of the X-59 construction contract to Lockheed Martin Aeronautics Company, completion of a delta Preliminary Design Review, and sonic boom characterization flights in the humid Florida skies. Looking ahead, the team is now planning for key decision point C and an exercise of initial community response data-gathering methods using the F/A-18 flying low boom profiles over Galveston, Texas.

Dr. Waggoner concluded his presentation by reporting that schedule milestones are being met, and everyone is very confident in the plan going forward and in the contractor's ability to deliver the X-59 on time and on budget.

Discussion

Mr. Borghese asked if there is a risk management plan, particularly in terms of having the funds available to deal with anything that comes up. Dr. Waggoner said they do have a plan in place. Estimates are still being made as to what additional funding may be needed to deal with the "unknown unknowns," but there is confidence that money can be found and set aside for those cases.

Dr. Clarke suggested as another test condition that the X-59 fly over thunderstorms, which generate their own noise, and gather public response from those below. Dr. Waggoner replied that it was an interesting idea.

Dr. Clarke asked if there were any numbers available for the effects of humidity on supersonic shockwave propagation as a result of the flight tests in Florida. Dr. Waggoner did not have those numbers handy but said he could provide them later.

Dr. Karen Thole asked what NASA would do if the public response to supersonic flight over land is "No, we don't want this. We don't like the boom." Dr. Waggoner replied that it is NASA's job to gather the scientifically sound, statistically valid data and present it to the FAA and ICAO. Dr. Shin added that, no matter the outcome, commercial supersonic flight over land will not be possible at all unless this data is produced.

The committee expressed its support and enthusiasm for the LBFD mission. In doing so, several members underscored their concerns that a plan be put in place for dealing with any unexpected issues that arise either during construction and assembly or during the flight tests.

Findings/Recommendations

The Committee endorses the Low-Boom Flight Demonstrator project and congratulates NASA for developing clear project objectives and an adequate yet aggressive schedule. The Committee observed that the risk mitigation strategy has been well-developed, and the goals of the project are clearly articulated. The Committee believes that the demonstrator will reinvigorate the public view of the role of Aeronautics within NASA and encourages the project to involve schools to take advantage of this opportunity to inspire the next generation.

List of Attendees

Present

Committee Members:

John Borghese	Rockwell Collins
John-Paul Clarke	Georgia Tech
Scott Drennan	Bell, Textron
Michael S. Francis	Consultant
Anil Nanduri	Intel
Tom Shih	Purdue University
Karen Thole	Penn State

Presenters and Audience:

John Cavolowsky	NASA
Mitchell Cho	FedWriters
David Could	NASA
Ravi Deepah	Science & Tech.
Shawn Engelland	NASA
Barbara Esker	NASA
Davis Hackenberg	NASA
Paul Krasa	NASA
Jessica Nowinsky	NASA
Lee Olson	NASA
Irma Rodriguez	NASA
Jaiwon Shin	NASA
Steve Spearman	FedWriters
Akbar Sultan	NASA
Huy Than	NASA
Mike Tsairides	
Ed Waggoner	NASA
Kevin Witzbergar	NASA

Remotely

Alina Eskridge
Arwa Aweiss
Ben Kallen
David Thipphavong
Gloria Yamauchi
Greg Bowles
Heather Arneson
Heather Bloemhard
Hemil Modi
Holz S.
Husni Idris
Jeff Maddalon
Jim Banke
Joe Morrison
Joe Smith
John Kaneshige
Karen Cate
Lou Glaab
Mark Aitken
Michael Patterson
Michael Rogers
Michael Tsairides
Nelson Guerreiro
Robert McSwain
Ron Johnson
Ronald Lehmer
Savvy Verma
Shawn Engelland
Shivanjli Sharma
Siena Whiteside
Susan Gorton (NASA)
Unmeel Mehta
Xiaofan Fei
Yuri Gawdiak