NASA Advisory Council (NAC)
Aeronautics Committee

March 22, 2017
NASA Headquarters, Washington, D.C.

Summary of Meeting Minutes

Participants:

First	Last	Organization	Role
Marion	Blakey	Rolls Royce North America	Chair
John	Borghese	Rockwell Collins	Vice Chair
Dr. John-Paul	Clarke	Georgia Tech University	Member
Dr. Michael	Francis	United Technologies Research Center	Member
Dr. Lui	Sha	University of Illinois	Member
Gen. Lester	Lyles	AF Retired	NAC Chair
Dr. Greg	Hyslop	Boeing	Member
Irma	Rodriquez	NASA ARMD	Committee Exec. Secretary
Dr. Jaiwon	Shin	NASA ARMD	Associate Administrator
Robert	Pearce	NASA ARMD OAA	DAA / Strategy
Jon	Montgomery	NASA ARMD OAA	DAA / Management
Alicia	Wesley	NASA ARMD	Staff
Dr. John	Cavolowsky	NASA ARMD	Director AOSP
Dr. Edgar	Waggoner	NASA ARMD	Director, IASP
Doug	Rohn	NASA ARMD	Director, TACP
Richard	Young	NASA LaRC	ACP Project Manager
Alan	Angleman	The National Academies of Sciences	Public
Doug	Farren	Sierra Nevada Corporation	Public
J.D.	Harrington	NASA	Public
Linda	Karanian	NASA	Public
Lee	Olson	FAA	Public
Michelle	Rodrigues	SRI International	Public

The meeting was called to order at 9:39 a.m.

Welcome and Announcements

Dr. Jaiwon Shin welcomed all attendees. Dr. John-Paul Clarke and General Lester Lyles attended remotely.

New Administration and Transition Update

Dr. Shin began the update with his impression of the new presidential transition team after briefing them in December. He was impressed about the team's interest to learn more about NASA's initiatives and goals so that the Administration can do its best to support the agency. The discussion highlights are below:

- The transition team had notable interest toward NASA's work with X-planes and UAS technology. Both the team and Congress have genuine interest and expectations for the Aeronautics Research Mission Directorate's (ARMD) low boom research to produce positive results for the United States and to reach actualization in the coming years.
- Update provided on NASA's preliminary budget released on Thursday, March 16th. It was noted that the Office of Management and Budget (OMB) could change the numbers, and that the actual budget will be released a little later than typical, in or around mid-May.
- Overall, Dr. Shin emphasized that NASA fared well with regard to budget, and provided perspective of other department budget percentages. Relative to other departments, ARMD experienced a one-percent cut for FY18, a total reduction of $10 million. NASA's Office of Education will be terminated, along with six to eight Earth Science projects and missions.
- Dr. Shin expressed that the present challenge is completing ARMD's X-plane initiatives and other emerging aeronautics technology within the current budget. It was asked about how Congress will respond to the President's goals with overall objectives and budget, specifically regarding cuts. In the past, discrepancies in proposed budgets were met with additional funds back from Congress. This might happen again under this Administration during the normal budget process course.
- Potential new projects in the current administration and budget expectations was brought up. Dr. Shin described what the process could look like if NASA leveraged its low boom research, which has been researched for years. On one hand, it can be argued that it is an extension of old work. However, others could claim that it is a new work because the low boom demonstrator X-plane is moving out of the concept development phase. These factors would determine whether NASA can initiate new LBFD project.
- It was stressed the importance of this newfound excitement over low boom research, which was a contrast from previous administrations. NASA is viewed as a model agency that cares how tax payer money is used, focuses on efficiency, not frivolously spending money. As a result, FY18 looks positive, as OMB specified that the administration – including Congress – supports low boom research, especially because it will benefit the US industry.

- Low boom was spelled out in the two-page budget release. The administration believes that NASA delivers results and thus, trusts the vision toward this initiative. The budget released is still not the final budget but drastic changes are not expected.
- It was announced that General Lester Lyles, who joined the meeting remotely, was named Chairman of the overall NASA Advisory Council, which was met with applause and congratulations.
- The X-planes was discussed in terms of how to prioritize this initiative under NASA Aeronautics' tight budget. It was indicated that convincing the public about the value of the X-planes project would ensure that NASA maintains the support it has for this project. The value has already been established, so NASA must find a way to talk to Congress, and emphasize what is needed to be done and continue advocating to accelerate the initiative in the next budget cycles.
- Accelerating the initiative could mean better or different partnership (e.g., Air Force Research Laboratory), or finding different ways to develop X-planes and elevate them to a national level. Military-to-civil transfer of concepts or vice versa is also possible. NASA expects that the Department of Defense (DoD), NASA, and industry will come together in a unified front to push X-planes into a reality. The United States needs to be first in producing this technology and continue to be the global leader in aviation innovation.
- Another point brought up was that NASA could also improve its communication on the civilian side. It was suggested that the two agencies (NASA and DoD) are aligned to bring revolutionary technology in the next 50 years and emphasizing the need to produce next generation technology in the 21st century. Both the commercial and military partners want new freighters, which is a solid start for NASA to fill in the gaps.

ARMD Integrated Strategy for UAS

Dr. Ed Waggoner led a presentation about the ARMD's strategy for implementing Unmanned Aerial Systems (UAS) into the aviation industry. A key issue is managing aircraft that are lighter, and require less power, while managing various levels of autonomy within the aircraft. A summary of the major points of discussion follows.

- Question regarding certification of UAS vehicles was raised. NASA indicated that it varies but NASA is currently working with the Federal Aviation Administration (FAA). ARMD expects full integration of UAS by 2025. In order for routine UAS access to occur, the requirements are: identifying and including the appropriate stakeholders and their needs, administering the FAA's integration strategy, and arranging a concept of operations and plans. ARMD must leverage information from government-wide research and development (R&D) analysis and FAA's R&D roadmap. Current UAS Traffic Management (UTM) rollout has been successful. As a result, NASA hopes to work with various start-up companies to begin the process of integrating autonomous systems in UAS vehicles.

- The main barrier now is the certification and quality of the autonomous systems. It was suggested that the current verification system in place – evidence-based certification – is not valid enough. The main issue is to reduce complexities within UAS and there are not enough safety checks. Complex systems are difficult to check so power and high performance become the focus. Therefore, in order to integrate UAS effectively, simpler UAS models are needed to ensure that safety checks rely on less assumption and can ensure more quality system certifications.
- Machine learning is the most important aspect as is software checks. No specifications are perfect, so it is important to apply the right technology to better inspect UAS.
- Another example provided was of intelligence software - Explainable Artificial Intelligence (XAI) from the Defense Advanced Research Project Agency (DARPA). Essentially, the software will morph before we can simplify the technology, and while we might not avoid complex systems, bugs can be fixed before we reach them if the XAI format is introduced into UAS.
- So far, UTM is most capable in managing rural occupation in mid-altitude heights. NASA is solving these problems and is actually closest to solving the rural problem. It is possible to focus in multiple areas because each region and altitude issue requires different solutions, especially because the hardest problem's solution may not trickle down to rural issues. Researchers are analyzing the relationship between size, weight and performance.
- What makes the urban environment so difficult to manage with in-between altitudes, is that this group includes the most types of purposes. As a result, policy issues must be addressed before UAS can take off in this mode. Adding a pilot on the ground is one solution.
- There should be policy for safe passage over shared space, and that regulation is needed to fly through the space and time corridor. It was expressed that discussions and market drivers exist for this question.
- The FAA has been debating for a while about enough empty space for emergency landings. Segregation of airspace is generally not allowed. For example, space launches, are an exemption from the segregation rule. While commercial space launch has limited space segregation, it causes major delays in flights at surrounding airports, causing disruption.
- A suggestion was offered for an equivalent to a traffic light where there are time-relegated separations that restrict when and where vehicles can go, as opposed to physical spatial segregation in the road like lines on the road.
- The UAS issue has been deconstructed as follows:
    - The toughest altitudes are low altitude, urban areas, which include UAS – or IFR-like aircraft -- that will focus on package delivery and trade space, and UTM is focused on construction, search and rescue. Public trust is a critical issue in this area as well due to noise, security, and environmental concerns. The smallest, lowest capability machines in this environment are in the toughest bracket of UAS. However, solving these problems will offer more benefits for commercial usage of IFR-like aircraft.

- It was suggested that the economy will decide what aircraft will shift technology and the NAS. Once initial UAS entry issues have been solved, other aspects, like regulatory changes and revolutionary UAS technology, will fall in line. NASA can look through the “opportunity lens”. Companies can develop autonomy, and NASA can develop certification standards and methods. NASA must look at the gaps in technology and focus their research and production there.
- Australia and New Zealand were suggested as the first countries to completely introduce UAS technology to a point where industry is able to fly where they wish.
- The United States has the edge in UAS integration because of its general approach to introducing technology to the public, its focus on standards, airspace density, and leadership. The nation’s next challenge would be maintaining that standard. How quickly could the country push the boundaries for flexibility?
- Another factor advantageous to the US is that other countries and companies might need FAA certification and would have to wait on US integration in order to continue their progress toward airspace occupation.
- While the United States’ leads in UAS technology, NASA reminded everyone to avoid minimizing the capabilities of countries. For instance, the Gross Domestic Product of aviation in other areas such as Dubai of the United Arab Emirates is around 30%.
- On-Demand Mobility (ODM) will leverage UAS technology and business, as highly autonomous systems open the door for UAS to achieve full private and commercial integration. As a result, NASA is working with industry and FAA to remove additional barriers.
- One barrier to ensuring the safety of UAS integration is the ability to detect and avoid other aircraft. NASA and its partners are developing technology for both high and low performance aircraft to detect aircraft in the vicinity. This relies on communication with ground pilot for the right information, so the challenge that NASA faces right now is deciphering the information and making effective adjustments. Researchers have conducted flight tests to ensure reaction times are accurate and timely, resulting in five prototype radio performances examined over mountains, water and other environments.
- Pilots are necessary in the event that a machine/computer cannot process a solution because machine intelligence is improving and changing the game on handling problems in the NAS. The UTM system is tackling issues in high altitude airspace. A nationwide demo will be scheduled in mid-June to test dozens of aircraft for system level solutions to manage the airspace.
- Figuring out how to integrate UAS is hard labor. NASA has struggled internally to work on the integration. NASA must take a holistic approach to solve UAS entry. There may be significant resources in the private sector that the government should look into. As a result, NASA should focus on solving problems that only the government can solve to enable UAS entry. Entry cost may be low, and others can take over the rest, like Airbus in Dubai. Nontraditional and traditional partners are needed, and the competition keeps NASA honest, but industry has the capabilities and technologies to make it happen.

On-Demand Mobility (ODM) Research Strategy

Mr. Doug Rohn presented NASA's On-Demand Mobility research strategy and began by defining ODM as "transportation where users have access to immediate and flexible air travel" with regard to trip origin, destination, and timing. The following summarizes the most important points of the discussion.

- Benefits of ODM travel - This conceptual mode of transportation is expected to be faster than cars, can cut down on time and cost with current air transport, and can have the potential to alleviate city congestion. An additional bonus is that the importance of this research is in line with ARMD goals.
- NASA is seen as the primary leader in the ODM community and has been able to form notable committees. This includes NASA's X-plane models.
- With all of the positive effects that ODM can provide to the economy and the public, it still faces significant barriers to exiting the conception stage and into full implementation, including finding the appropriate market, building stable interest, and technological barriers.
- It was asked how NASA determines the market and which markets and communities of interest will be pivotal in ODM emergence. One suggestion offered was that a viable market could include those that invest in high-end vehicles. People in this bracket typically have the resources to afford regular usage of ODM.
- The research has shown that the outcomes of workshops help to identify groups, markets, interest, and other factors. The groups that attended the workshop included venture capitalists, consultants, emerging and traditional aircraft equipment manufacturers, aircraft subsystems and avionics, professional and trade organizations, operators, academic leaders, and international and national governments. All of these groups are considered proprietors in successful ODM system implementation.
- Identifying ODM reference missions were of the highest relevance to workshop participants because they provide both near and long-term opportunities for new technologies, vehicles, operations and transformative ideas for the future.
- There was strong industry interest for VTOL reference missions, which involve small public use in mostly urban, low-altitude airspaces. Interest in this form of transportation is heightened because this could alleviate infrastructure challenges like runways and accessibility.
- NASA researchers have identified the framework and an initial entry timeline to guide industry in addressing barriers to ODM integration with technology roadmaps. Essentially, the goal is to make investments for long-term breakthrough in VTOL missions, while focusing on near-term early adoption for CTOL.
- NASA could lead in noise and annoyance modeling, autonomous simplified vehicle operations, community architecture modeling and simulations, airspace integration and flight procedures and creating an overall ODM vision. Regarding collaborations, NASA's researchers and engineers could work with partners and

industry to create and manage takeoff and landing area infrastructure, backup safety systems, manufacturing research, development and operations, test, evaluation and demonstrations.

- NASA benefits from being well-positioned and respected within the ODM community. It also works in NASA's favor that the ODM community works quickly and is looking forward to being a part of integration.
- ODM is important and this is the right time to get involved. Many companies participated in the meetings. They will come up with vehicles to sell, create adaption techniques and ensure that autonomy actually works. Workshops are an effective way to exchange knowledge productively.
- NASA can leverage both industry and government. NASA's role as a government agency leaves room for the ability to manage infrastructure because that is the government's responsibility. ODM won't be just a niche industry for the wealthy and rich, but it can be expanded into wider civil use, especially to save money on infrastructure.
- NASA should include the Federal Highway Association into ODM discussions because they can aid in infrastructure management and add additional insight to integrate the technology affordably and safely.
- Liability and safety concerns of ODM need to be managed in all self-driving vehicles, even in automobiles. Companies and government need to have the full picture before making this technology available to the public.

UAS/ODM Planning and Integration Discussion:

Mr. Robert Pearce led a discussion-based presentation about emerging markets that gear toward UTM and some barriers to this opportunity. Information about the Strategic Thrust Roadmap, NRC Studies, RFIs, and community vetting on UAS and ODM strategic planning will be available in about a month. Mr. Pearce stressed that NASA is not creating a new project, but integrating and capitalizing on already-done projects such as vertical lift, electric propulsion, NAS and flight projects. The focus is to make a holistic effort in the program to integrate emerging market requirements, align priorities and timeframes across programs, and use FY2019 budget development processes to drive investment decisions. The main discussion points are summarized below.

- Within this process, failure is possible because of the current state of UTM standards and limited rules. Speeding into this area of research and integration would lack consideration of successful profit or safety. As a result, open innovation can be a problem.
- Advice from the committee was sought on how to leverage funding, how to partner with organizations, and anything else the industry would deem vital to the success of UAS and ODM integration.
- Certification is an area to explore with partnerships, especially for intelligence certification. The help of the community would streamline the process.
- It's likely that a cultural change needs to occur within NASA. Typically, NASA has been great at decomposing the issue and then integrating systematically. The

thought process is serial. With UAS integration it's not as simple to do and unorthodox solutions might be necessary. It would be possible to collaborate with prominent companies that may not be aviation-related but could benefit from UAS and ODM technologies. NASA can be the nuclei to form the community. Overall, NASA ARMD's adjustments need to be behavioral and goal-oriented.

- The discussion of how NASA can keep the United States ahead in UAS technology is reminiscence of the space race between the United States and the Soviet Union. NASA experienced significant failures, but eventually the US was the first to the moon because of the risks taken. However with UTM, the stakes are very high because this technology will include civilian lives on the line who put their faith in the safety of the systems. Because there are lives on the line, UTM has to be very careful with integration. People are less likely to be forgiving of mistakes made in aviation, and such mistakes can be very costly for the industry.
- It was recommended to use virtual models of systems and cities to simulate the airspace which could be a crucial resource to ensuring a safe and smooth transition into full integration of ODM and UTM.
- NASA is currently transforming, and over the last few months, there have been many discussions about solidifying NASA's identity in the 21st century. NASA must earn the budget money that they need. NASA's best chance to achieve that is to create something the public sees. X-planes would provide a significant opportunity to cultivate a positive perception of NASA.

Advanced Composites Project (ACP)

Dr. Richard Young led a presentation updating the NAC about NASA's goals and approach toward advanced composites, their interactions with the FAA and DoD, technical challenges, budget updates and other details. He also examined the community team approach, and existing systems for applying advanced composite materials in modern aviation. Dr. Young's approach to ACP research is to look to academics for fresh ideas and future engineers; rely on the FAA for advice on safety, industry and NASA for technology and science. The main discussion points are summarized below.

- During the last two years, the working relationship between FAA and NASA has improved with the engagement of in-house FAA designees, as both agencies are working together on the research project. There is also more interagency coordination from the Air Force, Army and DARPA.
- It was asked why the project prioritized money for tools and testing over producing actual materials for the public to see. The project is aiming to focus on how researchers can take existing advanced materials and produce reliable products more efficiently. The tools do not vary that much, rather the basis and ways they are applied is the secret.
- To bolster NASA's work on advanced composites, the project has recommended relying on public-private partnership, or PPP. The PPP strategy solicits private

and public organizations to form with NASA to solve common challenges with costs and products shared by team members. The PPP strategy can sometimes face efficiency and communication challenges, along with difficulties in managing administrative overhead costs and technological management. However, the benefits to the PPP strategy are involving skilled and diverse teams and introducing multiple stakeholders to the market. PPP also connects government research with industry needs, and promotes standardizing technology since the top proprietors would be using similar techniques and technology while the FAA provides unified guidance and receives industry-coordinated approaches. While NASA will not rely on PPP for every project, because it has been working most of the time, it is something that this research team is interested in using more frequently.

- The greatest challenge to widespread usage of advanced composites is that prior to the administration's transition, many of the previously funded programs boosted this type of collaboration, but since it has dried up, the companies and agency have become more insular. Engagement is coming back to improve the transition of information and establish more connections to improve products.

Work Plan and Schedule Discussion

The work plan and schedule for FY17 was reviewed. Ms. Blakey led the discussion by comparing and contrasting FY16 and FY17. She concluded that the committee was ambitious in 2016. The committee covered a lot of areas in FY16 and the FY17 work plan is as ambitious.

To match the level of tenacity from FY16, Ms. Blakey initiated a discussion on expanding NAC meetings and finding the right facilities to host the committee meetings to make each meeting more productive. The next meeting is anticipated to occur late July with the new NASA administrator. NASA Langley Research Center is tentatively the top consideration for the location, considering the facility's 100th anniversary.

Committee Deliberations

Ms. Blakey opened the floor for committee members to state any findings and recommendations for NASA based on the topics covered. The committee summarized the two findings below for presentation to the NAC.

1. The Committee finds that the current NASA Aeronautics research portfolio is relevant and forward leaning, much more so than in the past. The Committee endorses the path that ARMD is taking and recognizes that it is headed in the right direction. NASA Aeronautics portfolio has a promising future in meeting National needs, and it is vital that ARMD continue to build strong partnerships with other government agencies and industry.
2. The Committee is encouraged by ARMD's investigation into concepts and technology for On Demand Mobility (ODM). Although this field is in the early stage of development, the Committee recognizes and agrees with the high potential of this emerging market. The Committee recognizes that there is a

fundamental question that needs to be answered regarding the roles of government vs. industry. NASA should not try to duplicate anything that industry is doing but focus on the most compelling areas that need to get accomplished by the government. The market is going to drive development of air vehicles but new infrastructure, certification and operational concepts, particularly in light of developments in artificial intelligence and autonomy, will be needed for the industry to flourish. In order for the U.S. to stay competitive and lead in this technology, the Committee believes that NASA needs to focus future work on these other areas in order to help the industry and the public. The Committee encourages NASA to partner with industry to learn a new way of thinking in a fast moving technology field. At the same time, NASA maintaining focus on infrastructure, certification, specifically as it pertains to autonomous systems and operational concepts.

Public Comments: There were no public comments.

MEETING ADJORNED at 4:11 p.m.