NASA Advisory Council Aeronautics Committee
Summary of Meeting Minutes
NASA Headquarters, Washington, DC
March 14, 2018

1. Work Plan and Schedule Review

Mr. John Borghese, NAC Aero Committee Chair welcomed everyone to the first meeting of the calendar year and provided some opening remarks. In his remarks, Mr. Borghese thanked Dr. David Vos for his service as a committee member as his term had ended. Mr. Borghese shared the Committee's work plan and schedule and asked the members for comments. Dr. Michael Francis suggested that this year will be a turning point in the transition and development of NASA's role in the field of autonomous systems. Dr. Jaiwon Shin agreed the subject of autonomy could be added to the work plan for the year and noted he will briefly cover this subject in the budget and strategy discussion.

Dr. Francis suggested strategic discussions be held because this is a technical and safety culture issue. Because aviation technology is driven by the Federal Aviation Administration (FAA), it is difficult for NASA to introduce new concepts. Dr. Greg Hyslop noted the burning platform is maintaining safety with more aircraft, new technology and fewer and less experienced pilots in the pipeline to become commercial airline pilots. To maintain safety while accommodating future increased demand, it might beget the need for artificial intelligence to assist. Dr. Francis concurred.

The upcoming NAC meeting in the summer will include more topics regarding autonomy, including Unmanned Aerial System (UAS) strategy and other air traffic management projects.

Following up on discussions about NASA's plans regarding autonomous systems, Dr. Clarke suggested he and Dr. Francis come up with questions to initiate discussions with the Committee about NASA's role.

Dr. Francis noted NASA should move beyond a tactical approach to autonomy and develop an agency approach of attacking this issue.

Mr. Borghese added that other government agencies spent a lot of funds on research and development in the field of autonomy last year. He agreed with Dr. Clarke that NASA's approach to safety issues will require a culture adjustment. Mr. Borghese said that while start-up companies and other members of industry may develop autonomous technology and structures, safety might not be their priority. Additionally, NASA should focus on what the country is interested in regarding autonomous systems.

2. FY19 ARMD Budget and Strategy

Dr. Jaiwon Shin, Associate Administrator of the Aeronautics Research Mission Directorate (ARMD), announced the current NASA Acting Administrator, Robert Lightfoot, will retire April 30, 2018. He noted while there is not a succession plan in place at this time, there likely will be

an acting administrator in the interim. However, Dr. Shin assured the Committee that major activities will be completed regardless of the shift in leadership.

Dr. Shin shared the current FY20 ARMD budget for fiscal years 2019 through 2023 and provided an overview of the ARMD strategy that was provided with the President's budget submittal.

Dr. Shin responded to Dr. Francis' inquiry about new projects for NASA, noting NASA currently does not have an approved budget and cannot initiate any new projects. Dr. Shin added his assurance the Office of Management and Budget has confidence in NASA and ARMD.

In response to Mr. Borghese's question about future budget reductions affecting personnel, Dr. Shin noted such reductions reduce the number of new hires, and he expressed concern that future workforce size may be negatively affected if projected budgets continue to be reduced. He added the New Aviation Horizons initiative will not be implemented as originally proposed because of the budget cuts. However, NASA staff has prepared for the challenges, and Dr. Shin said interagency collaboration would assist ARMD's mission. NASA will have momentum going forward through the rest of the fiscal year as the groundwork is laid for the Low-Boom Flight Demonstration mission.

Dr. Hyslop commended Dr. Shin on his leadership in strengthening the relationship between NASA and the FAA. NASA recently hosted a large UAS strategy convention with stakeholders. More than 1,000 people attended, making this event the largest attended NASA-led conference. During the event, the FAA showed it is committed to ensuring the success of UAS Traffic Management (UTM), in addition to the development of electric aircraft to improve fuel efficiency and reduce noise.

Dr. Francis suggested NASA combine UAS Integration into National Airspace System and UAS Traffic Management programs into one holistic approach to the airspace. Dr. Shin responded that ARMD is approaching research in this area with a unified strategy, noting while there is one airspace, there is significant variety within that airspace of vehicles and challenges including different forms of UAS, such as drones, commuter vehicles, and high-altitude vehicles. Dr. Clarke added NASA should be clearer about the distinction between the goals of the two programs. Dr. Shin concurred and will seek to better articulate a complete integration solution.

Dr. Eric Ducharme asked if there was overlapping technology R&D within NASA's Space Technology Mission Directorate to complement ARMD's missions. Dr. Shin agreed with the suggestion to support missions in a more general sense as an entire agency and noted agency efforts to manage/understand underlying capabilities within NASA to ensure cross-agency engagement and support. He noted there might be opportunities for ARMD to leverage intra-agency research on autonomous systems and advanced materials. In addition, the Committee suggested working with other agencies. Dr. Shin concurred, specifically noting collaboration on hypersonics research. Dr. Shin and the Committee agreed that the field of hypersonics represents a national security issue, especially considering countries that are seeking to be competitive in aeronautics research and are heavily investing in this technology. Additionally,

the Department of Defense is accelerating its work on hypersonics. However, to focus more research in this field, NASA will need more funding and directives to that end, preferably without sacrificing another project. NASA has proposed $30 million per year toward hypersonics research, an increase of $5 million over previous budgets.

Dr. Ducharme suggested NASA create clear performance-based outcomes and goals for each of these programs and focus on opening markets that may not currently exist. He proposed setting these goals in the context of industry capabilities and regulatory initiatives so that ARMD can clearly articulate how NASA's contribution is contributing to market needs. Dr. Shin concurred with this suggestion and added FAA offices are meeting with industry to understand their needs as they develop their regulatory initiatives. Dr. Hyslop tied NASA's advanced materials research to Dr. Ducharme's point, noting the next transport airplane should not look conventional. Dr. Hyslop was curious to see how much industry is willing to provide their own funding.

The committee discussed how air transport more broadly can contribute to society mobility, with committee members noting some states and municipalities already are considering shifting investment from bridges and highways to air transportation (i.e. vertical take-off and landing (VTOL) flight or other methods) to transition more to air travel for future mobility needs. The Committee then discussed how that infrastructure might look once VTOL becomes mainstream, suggesting opportunities such as the possibility of turning abandoned areas in urban locations into VTOL stations.

Dr. Shin described ARMD's intent to pivot from the existing technology portfolio to research focused on enabling these new markets and ensuring that the NASA investment is sizable enough to make a difference. He described establishment of the Urban Air Mobility Team, a cross-center and cross-project team of subject matter experts who are identifying priority investment opportunities to support this pivot and support for UAM. Several members recommended that, to be successful, NASA researchers need to engage with the external community to show relevance and ensure ideas are coming from everywhere. They indicated this should be done in a timely manner to avoid the possibility of researchers becoming so tied to a concept that there is a difficulty in adapting to new technology and allowing permission to expand and become a leader in newer NAS introductions and clearance to fly.

The Committee supported NASA's pivot and believes that UAM is likely to be successful, but that infrastructure will be a primary obstacle to address, so early efforts will likely be centered around building VTOL hubs to balance convenience with costs, comparing the concept to that of subway stations.

Dr. Shin noted many of NASA's projects end in 2020, including Airspace Technology Demonstration, and UAS in the National Airspace System, while Advanced Composites will end in 2021. Dr. Shin asked the Committee to share their thoughts on this matter. The Committee suggested NASA should include more unique and progressive stakeholders more often in its market research and planning—a group that includes city planners, real estate agencies, and state governments.

RECOMMENDATIONS/FINDINGS

The Committee agreed that ARMD's overall portfolio and strategy are aligned to support the future of aviation by being the enabler for new vehicles and airspace. In particular, the committee endorses research in the areas of autonomy and electric vehicles. The Committee also believes that ARMD research should be directed in areas that are not being addressed by commercial industry and other government agencies. These areas could include certification of autonomous systems and airspace management, and other certification methodologies needed for these new classes of vehicles.

3. System-Wide Safety Report

Mr. Borghese provided an overview of the recently published National Research Council (NRC) report on system wide safety. He was a member of the committee that developed the report for NASA. The study identified ten priority research areas, including developing an Integrated Aviation Safety Management System (IASMS) concept of operations.

Dr. Jessica Nowinski, Airspace Operations and Safety Program Technical Advisor for Safety, presented a summary of planning for the System-Wide Safety (SWS) project, drawing on internal planning concurrent with the NRC study and noting a fair amount of synergy and overlap among the two. NASA is adding the idea of an IASMS CONOPS to its planning to better define the NASA vision for safety capabilities. The Committee noted that industry is doing a lot in the area of safety and recommended NASA benchmark what industry is doing in aviation and other sectors to understand what is happening and leverage these other activities as appropriate.

Dr. Clarke asked if NASA is using a statistical or domain-derived algorithm. Dr. Nowinski noted that NASA has developed a statistical anomaly detection tool which ranks flights according to their similarity to other flights on a large number of parameters. Currently subject matter experts are employed to determine whether the identified anomalies are safety relevant. The NASA team is working on automating this evaluation process. Additionally, NASA has developed a multi-variable search tool that allows researchers to mine the data for additional instances that are similar to the safety-relevant anomalies.

Mr. Borghese asked if Dr. Nowinski's researchers have access to data from the National Airspace System. Dr. Nowinski said her researchers have airspace data from the FAA, through the Research Transition Team, and work directly with airlines for access to flight data. In addition, MITRE has developed a sandbox database to accommodate NASA's (and other) requests for access to ASIAS data for research purposes. Mr. Borghese indicated his concern about how the staff calculates and determines the cause of a crash, environmental conditions, training, and system failures. Dr. Nowinski stated that determining those factors was the inspiration for the first technical challenge. The researchers are focused on exploring how factors increase vulnerability and how those factors interact to change safety margins; however, this work has just begun.

Dr. Francis noted NASA should consider what is an “acceptable outcome” when it comes to safety and failure in autonomous vehicles, from the lowest level to their most operational. Additionally, he said identifying the acceptable outcome goes beyond certifying the software and includes assessing how the system reacts in various circumstances. Dr. Francis then said the need to consider UAS safety mitigations may change the definition of certification. The Committee wants to explore how to acquire the data to make this determination.

Dr. Hyslop added cybersecurity in SWS is an important factor that should be researched. Additionally, he noted a new air traffic control system may be required to preserve SWS and ensure secure management of future systems that do not yet exist. Dr. Nowinski added cybersecurity is a top priority and is included in recommendations from the NRC.

In the Committee’s request for more deliverables, Mr. Borghese suggested the SWS project scope being considered currently may be too broad and recommended more specific outcomes for FY2018 and beyond. Dr. Nowinski said her team has developed more specific deliverables for each year through the life of the project. This particular presentation details work to support the early stages of the 30-year plan. The team will work to provide measurable impacts as they develop capabilities and work with airlines and the FAA. The new capabilities will be transferred to partners and industry as soon as they are completed. Additionally, the SWS team is working with the UTM team for further integration. Dr. Nowinski concurred with the Committee that SWS is a community effort.

The Committee expressed concern there is not a lot of data available, and the SWS team will need a model to acquire data sets, adding certification is beyond aircraft technology. Dr. Ducharme recommended creating benchmarks for large data mining would be a good opportunity to help narrow down the needs in this area.

RECOMMENDATIONS/FINDINGS

The Committee found that the SWS has many facets and NASA needs to identify which research activities would provide a real payoff and focus on specific areas. They understand that this project is in formulation and supports ARMD’s intent to focus on topics where NASA can provide unique and important contributions to the safety of the NAS as traffic density increases and new entrants enter the airspace. The Committee also believes that SWS should address the cyber security element of NAS management and clearly define yearly objectives.

4. Advanced Materials and Structures Research

Dr. John Cavolowsky, Program Director of the Transformative Aeronautics Concepts Program, presented the cross-program effort in advanced materials and structures research. Dr. Cavolowsky noted while this is the next step up from previous advanced materials research initiatives, this initiative is a new concentrated, strategic-level assessment for materials and structures as a core discipline technology area. He indicated that the briefing provides a glimpse into early thinking and the purpose is to seek an initial reaction and get feedback from the Committee. The strategic framework is expected to span from 2020 to 2030.

The Committee indicated that ARMD should aim to describe practical outcomes in future briefings. Dr. Clarke suggested the team could research multifunctional materials of different densities that can concentrate acoustic benefits and redistribute heat generation. Dr. Cavolowsky concurred, noting this would be useful research.

Dr. Cavolowsky also confirmed this strategic framework has materials that can be applied to hypersonics projects while looking 20 to 40 years ahead. He added his program could provide further explanation in future meetings to show how his staff is thinking about hypersonics application and related deliverables.

Dr. Cavolowsky noted the "Computational Materials and Structure (Systems)" portion of the advanced materials research addresses the types of models that can be designed using new materials. This includes developing atomic and molecular structures and outfitting the materials to nano-, micro- and meso-structures. Following this step, researchers will assess the components, and assemble and complete the system. Dr. Hyslop said he believes the ability to design the material at the same time as designing the part which uses the material, and at the grade of quality appropriate for the part, has the opportunity to really "unlock" a new engineering capability.

Dr. Thole asked how the Advanced Composites Project (ACP) team interfaces with existing efforts, such as the National Network for Manufacturing Innovation. Mr. Dale Hopkins responded, saying the ACP staff coordinates with the National Institute of Standards and Technology to discuss components and integration, as well as to vet new materials with local industry, engineers, and other government agencies. He added they can accomplish this through NASA research announcements.

Dr. Thole recommended the team focus on integrating technologies into aircraft parts, such as embedding sensors into aircraft parts. Mr. Paul Krasa of the Advanced Air Vehicles Program (AAVP) concurred with Dr. Thole of the potential benefits of embedding sensors into parts during manufacturing, as opposed to adding them later, and noted the team has researched integrating sensors into aircraft parts and, at the same time, assessing their life cycle and certification, among other factors.

The Committee suggested that project teams within this area of research be more explicit about their vision and plan. Dr. Clarke recommended developing a whole data set and allowing for upgrades for unknown factors.

Dr. Thole asked Dr. Cavolowsky if his research team has considered the impact to industry in using powdered metals versus traditional materials. Dr. Cavolowsky responded, saying the program aims to improve the integrated planning of advanced materials, as the concept design is moving faster than the ability to qualify and certify those materials. As a result, coordination of the research must occur to match the pace with the economy and manufacturing demands. In this case, Dr. Clarke suggested the research team articulate delays in research to manufacturers.

Mr. Krasa noted there is a gap between computer models and actual integration in the lab. Dr. Thole suggested NASA focus on materials development in the aviation industry, instead of on manufacturing. Mr. Hopkins clarified that NASA plans to develop models with higher quality and fidelity to better predict how these materials form and to determine their lifetime performance.

Dr. Thole and Dr. Clarke discussed the importance of keeping detailed records of the conditions to which a given advanced material part has been subjected during its lifetime, to include what needed repair, what replacement was required, and how those replacements interacted with the system. Dr. Ducharme noted there are traceability methods available, to which Mr. Hopkins added an explanation of the process NASA currently uses to trace the history and pedigree of the system. Dr. Cavolowsky clarified further, adding that under ACP, NASA uses state-of-the-art methods to determine the standards and evolution of advanced materials, but focuses more on integration and certification.

Mr. Borghese expressed concern that, based on the presentation, the project may be addressing a large area that is also being addressed by other agencies and industry. He recommended that the effort be tailored to specific needs. Dr. Cavolowsky concurred the program needs more focus. Dr. Ducharme recommended a focus on what needs to be unlocked in the advanced materials industry, and not necessarily on execution of the materials. Dr. Francis suggested the function of the technology or the application of advanced materials should be determined. Dr. Shin emphasized that the project is in its preliminary stages and will use a rigorous process to narrow down its objectives. Dr. Thole indicated the Department of Energy in concert with the National Research Council is initiating a study on advanced manufacturing for turbines which should be of high interest to NASA.

RECOMMENDATIONS/FINDINGS

The Committee appreciated being part of the initial planning of this project in order to provide feedback in its infancy. The initial planning has displayed insights into the interrelationship of core areas, including advanced manufacturing, computational materials and structures, multifunctional materials and adaptive structures, and the issues of qualification, certification and lifecycle sustainment. The Committee believes this research is very important. There is significant multi-agency investment in the government's new manufacturing initiatives that NASA should evaluate and integrate with the national endeavor in this area and focus on specific needs of aviation where there are gaps in the research.

5. Electric Aircraft Technology Development

Ms. Barbara Esker, Deputy Director, AAVP, presented an overview of the latest in electric aircraft technology development. Ms. Esker noted the briefing does not include many technical details; however, she indicated she would provide data to Committee members afterward if desired.

Ms. Esker presented that electrified aircraft propulsion concepts can be considered in four categories: turboelectric, partially turboelectric, hybrid-electric and all-electric systems. Mr. Borghese noted the hybrid-electric propulsion system is different from the electric propulsion

aircraft that has matured over the years, and asked Ms. Esker about the current level of efficiencies. Ms. Esker indicated that, currently, a proposed single-aisle turboelectric aircraft with an aft boundary-layer ingestion propulsion system could yield efficiencies of a 12-percent improvement of potential fuel burn reduction, but her team is looking to increase this figure. While Mr. Borghese expressed concern that this efficiency level is insufficient, Dr. Hyslop noted, at this stage in the research process, a potential 12-percent efficiency improvement is significant enough when compared to other research. In addition, Dr. Hyslop expressed confidence, noting if this improvement in efficiency can take place for smaller planes, it may eventually be extended to larger aircraft. Ms. Esker acknowledged both Mr. Borghese's and Dr. Hyslop's comments, adding that her team is assessing the reference (baseline) and the contributors to the 12 percent improvement.

Ms. Esker shared that the location/configuration of boundary layer ingestion propulsion would make a difference in system-level benefits. Ms. Esker indicated these results will assist AAVP in developing its subsonic transport technology strategy. This strategy would keep the United States competitive in aircraft efficiency by developing transformational propulsion and airframe technologies that reduce energy usage by more than 60 percent, reduce harmful emissions by more than 90 percent and reduce noise by more than 65 percent. The Committee approved of this goal.

Ms. Esker explained that NASA's commercial electric VTOL research is newer than single aisle transport research. Furthermore, this emerging industry is increasing their recognition of the importance of safety and increasing its focus on safety. Dr. Hyslop concurred with this, adding that each aircraft category will experience its own challenges and maintaining high standards is a necessity, especially considering one crash incident has the possibility of halting an entire industry. Ms. Esker agreed, and added that, going forward, while developing investment plans for each aircraft category, she will determine the unique challenges and needs that each community must address.

In response to Mr. Borghese's question about whether AAVP expects to build another X-plane, Ms. Esker noted, while there are no plans to build new X-planes, her program will present a portfolio of technologies for industry to develop. Mr. Borghese also asked whether these other designs would offer more than simply the opportunity to test parts, to which Ms. Esker noted her program might work on developing models at a later date for testing purposes.

During Ms. Esker's presentation of the four categories of turboelectric aircraft, Dr. Hyslop suggested these propulsion systems over time will need to be able to generate more power. Ms. Esker shared that her team exchanges ideas and shares research with other agencies that work the advanced power area. The goal is to develop electrical machines that have two or three times more power density than is currently available. Devices that do not meet the power expectations are no longer considered. Ms. Esker added NASA work collaboratively in its electric aircraft propulsion research with the University of Illinois and Ohio State University.

The Committee was impressed with Ms. Esker's presentation about materials for electrified aircraft propulsion. Dr. Hyslop shared approval of Ms. Esker's team and the advanced materials team collaborating to produce new materials that reduce mass and improve efficiency of

converter filters and electric machines. He noted it is also a great area to develop tie-ins within NASA to boost the effectiveness of NASA's budget.

Following the VTOL safety discussion, the Committee explored other issues for AAVP's electric aircraft technology researchers to consider. Dr. Clarke recommended adding structures research to reduce the cabin noise that may be associated with electric propulsion aircraft. He also suggested NASA should remain aggressive in its research and stay ahead of competition, adding immediate action will be in NASA's best interest. Mr. Borghese added the FAA has been increasingly supportive of this goal.

Dr. Francis expressed concern about potential flight test locations and recommended the equivalent of an urban test range, similar to the one for UAS research. The Committee agreed that while an urban test range is critical in effective VTOL and electrified aircraft propulsion research, the test flights should not be done in populous cities like New York or Chicago. NASA should explore the right environment to push this technology.

Ms. Esker indicated the X-57 Maxwell aircraft has helped NASA develop new insights. Dr. Hyslop added NASA's unique advantage in research and integration is that it is close to the regulatory organization. Dr. Ducharme suggested NASA could present itself as an "open-source platform" to encourage further research. Dr. Clarke said UTM research successfully used open-source strategy and experienced significant benefits as a result. Dr. Thole also noted this program would benefit from improving its ability to predict the next important component to develop. Dr. Ed Waggoner shared the next steps in the X-57 electric propulsion research, which include baselining the vehicle, repositioning the motors, and developing a fully integrated system, adding this will occur incrementally.

Mr. Borghese returned to the topic of NASA's success in UTM engagement with industry, academic, and government partners, and asked Ms. Esker whether her program has invited potential candidates to review research and determine the market. Ms. Esker indicated some of the areas within her research are highly competitive, so one-on-one discussions have been the most helpful method to determine community needs.

RECOMMENDATIONS/FINDINGS

The Committee was impressed with the direction the electric aircraft technology team is headed and how they have used the National Academies' Low Carbon study results to guide that direction. The Committee also suggested NASA's goal be to uncover the regulators primary focus areas, inspiring solutions for validation, verification and certification while working with industry to address these challenges. The Committee was very impressed with the hybrid electric system research activities and encourages the project to focus on modeling the efficiency of the various configurations.

7. Public Comment Period

There were no public comments. # # #

List of Attendees:

Name	Organization	Role
John Borghese	Rockwell Collins	Committee Chair
John-Paul Clarke	Georgia Tech	Member
Eric Ducharme	GE	Member
Michael Francis	Former UTRC	Member
Karen Thole	Penn State	Member
Irma Rodriguez	NASA ARMD	Committee Executive Secretary
Jaiwon Shin	NASA ARMD	ARMD Associate Administrator
Ed Waggoner	NASA ARMD IASP	Director
Jay Dryer	NASA ARMD AAVP	Director
John Cavolowsky	NASA ARMD TACP	Director
Dale Hopkins*	NASA GRC	Deputy Project Manager, Transformational Tools and Technologies Project
Paul Krasa	NASA ARMD AAVP	AAVP Process Advisor
John Koelling	NASA ARMD AOSP	
Jessica Nowinski*	NASA ARMD AOSP	Technical Advisor for Safety
Angela Tvarozek	FedWriters	Writer
Alicia Wesley	NASA ARMD	Program Support

*** Joined remotely by Webex**