NASA Advisory Council Aeronautics Committee

Summary of Meeting Minutes
AERO Institute, Lancaster, California
November 15 – 16, 2017

1. Low Boom Flight Demonstrator

Dr. Ed Waggoner, Director of the Integrated Aviation Systems Program, provided an overview of the Low Boom Flight Demonstrator (LBFD) to the Committee. The LBFD represents NASA's return to flying large, piloted X-planes. The LBFD will be flown to generate data the Federal Aviation Administration (FAA) and the International Civil Aviation Organization (ICAO) can use to establish noise-based rules for enabling commercial supersonic flight over land. This will be done by flying the LBFD over U.S. communities of various sizes and different geographic locations to survey the general public as to the "annoyance level" of the quieter sonic boom.

A Preliminary Design Review was completed this year on a Lockheed Martin-designed vehicle known as QueSST, short for Quiet Supersonic Technology. Request for Proposals were put out and due in October in a full and open competition for designing, building and flying the LBFD. A Source Evaluation Board is now meeting to make a contractor selection.

The committee within ICAO that is focused on noise, the Committee for Aircraft Environmental Protection (CAEP), meets every three years. Their next meeting is in 2019. A work plan is laid out that identifies what needs to be completed at that meeting (and the one in 2022 and 2025) at which time it is hoped the CAEP will be able to formally accept the data generated by the LBFD.

Ultimately the LBFD work can be boiled down to three major requirements. First is the need to build and design a demonstrator capable of producing a representative low sonic boom that a commercial supersonic aircraft would generate. Second is the need for a test methodology to accurately survey community response to supersonic overland flight. Third is to make sure the data is representative of a demographically and geographically diverse, non-biased population.

Management of this program will be accomplished through the use of a Virtual Project Office, which enables more efficient communications among team members across the aeronautics field centers and helps establish a clear chain of command that streamlines the decision-making process. The LBFD program will include an independent review board.

Mr. John Borghese asked who was responsible for the community response effort. Mr. Jay Dryer answered that it fell within his AAVP program and that his team is working closely with the FAA, the CAEP and other international organizations.

The importance of public engagement in terms of community relations and education about the supersonic testing and the benefits of commercial supersonic travel was stressed by several members of the committee. Segments of the public will be skittish of any sudden noises from an unknown origin or concerned about sonic booms that could damage their hearing or fragile household items. Demonstrating to the general public there is a viable market for commercial supersonic travel also is a consideration.

Dr. Karen Thole had specific suggestions about engaging younger students, for example, by creating LBFD-specific science experiments teachers could do in the classroom. She suggested adding a teacher to the communications team and was informed about the Einstein Fellow that works with ARMD each year.

Defining exactly what “annoyance” means to the general public – not to the most annoyed or easily annoyed person – was discussed by among several committee members who shared observations and personal anecdotes on the subject.

Mr. Borghese asked about the configuration of the LBFD in terms of trade-offs between using parts of other aircraft and the need for designing/building new components unique to the aircraft. A complete answer will not be available until the final design of the LBFD is determined.

The committee asked about surprises seen with Schlieren imagery that computational fluid dynamics (CFD) runs did not predict in regard to flying low boom profiles with the F-15. The response was that some of that was unique to the F-15, but also noted the learning never stops and that detailed CFD and wind tunnel runs provide data that can later be validated using other techniques.

Mr. Borghese expressed concern about the use of a virtual program office, noting problems in the model as demonstrated by failures in a number of U.S. Army programs during the past decade. Dr. Ed Waggoner responded to his concerns by providing more details about how the new virtual office would work.

Dr. Thole stressed the need to really think through having a comprehensive educational program related to the low boom activity and especially target young people.

Dr. Thole expressed her concern that NASA not forget the lesson learned with the Schlieren imagery which indicated surprises are still possible despite detailed CFD runs, perhaps providing an opportunity to further build up CFD capabilities for use on the design and testing of the LBFD.

Dr. Eric Ducharme applauded NASA’s work to date on identifying success criteria for LBFD, but suggested even more could be done given NASA has not fielded a manned X-plane for some time. A review of recent flight test incidents would be valuable for identifying lessons learned.

Dr. Ducharme commented that in standing up the Virtual Project Office, getting the best available talent and establishing the right kind of operating rhythm and connectedness with the team will be very important.

Dr. John-Paul Clarke raised the thought – in terms of global thinking and considering all the data that will be generated and is already available from other sources, such as Gulfstream – of how NASA will structure that information to build a body of literature that will help make the case for changing the rules about supersonic flight over land.

RECOMMENDATIONS/FINDINGS

The Committee expressed excitement and applauds the progress of the Low Boom Flight Demonstration (LBFD) project and is looking forward to staying abreast on the future steps.

The Committee emphasized the importance of community outreach and provided examples on how to involve students to learn about NASA efforts.

The Committee also applauds the single chain of command employed on LBFD as being important to the success of such a large program as well as using the best talents across ARMD locations but cautioned NASA to take careful consideration as to how the virtual office is set up so that there is a clear understanding of the line of authority.

The Committee also applauded outreach from other parts of NASA as well as the risk reduction underway and suggested that risk reduction projects be funded to the extent necessary since NASA hasn't developed a manned X-plane recently.

2. System-Wide Safety Assurance Project Objectives and Content

Dr. Jessica Nowinski, Technical Advisor for Safety in the Airspace Operations and Safety Program (AOSP) briefed the Committee on the developments in the System-Wide Safety (SWS) project. In developing a SWS project, there were two objectives: better understand what the emerging, near-term safety issues are and what the future safety issues will be. Current commercial aviation is extremely safe now, with no obvious major concerns. But that could change with the rapid introduction of new technologies, more complex and autonomous systems, and new concepts of operations with new vehicles.

So, a major objective of the project is to proactively develop tools and techniques to address the safety threats in those areas and address them before there are unfortunate accidents and incidents. To address these concerns, five different technical challenges were developed, with the first two starting in FY2018.

There was a question about NASA working with the Air Force in this area. Dr. Nowinski explained that there are formal agreements in place with the Air Force Research Laboratory, but not yet with the Defense Advanced Research Projects Agency.

Dr. Clarke asked about high fidelity flight simulators and if this project was working in this area in terms of better training to avoid safety issues in the future. Dr. Nowinski replied that the project was not working in this area, but could in the future if directed to.

Dr. Clarke asked about envelope protection and the ability to fuse different data streams to recognize when an aircraft is flying beyond its certified envelope of operation. As it relates to state awareness, for example, how can an aircraft know when it is experiencing icing and that the pitot tube measurements are wrong. Mr. Bob Pearce replied that issues related to the risk chain and how to recognize and mitigate them will be addressed as part of the technical challenges established for this project.

Dr. Clarke cautioned that in data science, particularly machine learning, every correlation appears to be a causality. NASA should be sure to dedicate enough resources to address false positives of spurious correlations.

Dr. Thole suggested that as the system wide safety effort evolves to the point where less data is available, this could be an opportunity to partner with and engage universities to fill in the gap by generating data in a more controlled environment. This would have the additional benefit of exciting students about engineering.

Dr. Ducharme offered that in addition to the recent history of events identified during the briefing, the team also study the A330 incident from Brazil and the 777 incident at San Francisco.

Dr. Ducharme agreed the focus on safety in the emerging areas of autonomous systems is really important and reminded everyone “of the obvious” fact that this area is going to move fast, so it’s critical that NASA has established appropriate connections with the FAA and others. He said he did not have a good sense of how NASA is currently integrating with the FAA in this area.

Dr. Ducharme applauded NASA’s engagement with industry in the area of software verification and validation, as that, too, is becoming more complex at an ever-faster pace.

FINDINGS

The Committee finds that the System Wide Safety (SWS) project has progressed well and provides an opportunity to get students excited about engineering. Specifically, the Committee encourages NASA to partner with universities in generating data – data is hard to get and it could be a space that universities can help fill.
The Committee cautions NASA to engage with the machine learning community with particular focus on false alarms in the system. The Committee agrees with NASA’s

focus on Terminal Area Operations within traditional aviation and UTM (UAS Traffic Management) for near term needs to support unmanned and autonomous systems.

The Committee recognizes that SWS is a big challenge and agrees with the approach to start with a few tasks first to gain an understanding of the effectiveness of the technology. The SWS team should also keep abreast of new algorithms and approaches in this rapidly moving technology area.

3. Hypersonic Project

Mr. Jay Dryer, Director, Advanced Air Vehicles Program (AAVP) presented to the Committee the Hypersonic Project. AAVP has just completed one year of execution of the new Hypersonic Technology project. The work focuses on air breathing hypersonics missions, including support for military missions and pioneering civil missions. Although space access is one of the ultimate applications of hypersonics, NASA Aeronautics is not working on a specific vehicle design or mission concept.

NASA Aeronautics' current role is based in part on input solicited and received from industry and the Department of Defense (DoD), as well as by surveying other mission directorates at NASA. That role includes fundamental research to support development of new expendable and reusable systems, starting small and evolving to larger concepts, for both civil and military applications.

Technical challenges for hypersonics will be divided into four themes: system level design, propulsion, vehicle technologies, and high temperature, durable materials.

NASA is working closely with the DoD in this area to ensure research is not duplicated. Part of this partnership includes an emphasis on developing the future workforce.

Mr. Borghese asked about limitations or barriers to what could be shared or made public about its fundamental research, given the DoD connection. Mr. Dryer explained they are sensitive to this and are working within rules related to ITAR export control and national security guidelines. The desire is to be as open as allowed.

It was asked to what extent would the hypersonics project address thermal protection system technology, an area in which the space side of NASA has much experience. Mr. Dryer answered this area is not part of NASA Aeronautics research policy by direction of the NASA Chief Engineer. The Space Technology Mission Directorate is responsible for entry, descent and landing (EDL) research.

With research roles clearly understood between NASA and the DoD, NASA has an opportunity to produce important validation data sets and must find the best way to share the right information across the community. Also noted was the trust NASA has gained with the DoD is important, and moving forward, that engagement must be at multiple levels, from the engineer to senior manager.

An important aspect to hypersonics is manufacturing and the manufacturing readiness level for newer materials in terms of their use in additive manufacturing and their availability within a supply chain. Other areas to pay attention to include leveraging NASA research in staged combustion and lean burn commercial applications, a focus on how best to communicate and work with the DoD on retiring risk, and keeping the emerging work force in mind by always looking for ways for NASA to collaborate with academia.

Dr. Clarke indicated that as different concepts are worked on, be sure to cover the space in terms of technology development and not pass judgement on which ones will be successful or not. Just provide the base from which others can move forward.

FINDINGS

The Committee believes that the work that NASA is doing is important in order to maintain US supremacy in Hypersonics by developing tools, technologies and methodologies as well as training the future workforce in this area. The project has a clear focus on the understanding of the fundamental physics of transition for multi-mode hypersonic engines and other key hypersonic phenomena and technologies and NASA has an opportunity for important technology validation. NASA also has a focus on the important challenge of understanding and validating the quantification of uncertainty, as minor changes can have a significant impact to vehicle performance.

The Committee expressed concern that NASA project personnel have to access to the data collected even in cases where the data is sensitive.

The Committee also suggested outreach opportunities with universities in this important area for the US.

4. Autonomy Thrust - Unmanned Air Mobility (UAM) Update

Mr. Robert Pearce, ARMD Deputy Associate Administrator for Strategy, updated the Committee on the Urban Air Mobility (UAM) strategy within the autonomy thrust. Although labelled as “Autonomy,” the topic discussed was broader in terms of convergence and transformation, and how NASA is approaching emerging markets. Industry input to help determine research activities will remain a key to success.

While answering fundamental questions in areas such as improving performance and efficiency always remaining part of the equation, a key element to be addressed is how to enable this new market to actually operate, particularly as part of the National Airspace under different traffic and weather conditions.

Multiple users providing different services will require more flexibility. New entrants want to move faster in terms of design, testing, and certification than long-established

timelines. NASA must find ways to engage in this process and add value, and be ready to adapt to changes at every step.

In examining all possible vehicle modes and use cases, NASA will look to address common areas in design and vehicle certification issues, operations, procedures, noise and other forms of community impact, and most importantly, safety.

A virtual mission development integration office (vMDIO) model, similar in concept to the LBFD virtual program office, soon will be put together to effectively and efficiently manage this research area across all four participating NASA Aeronautics field centers, as well as industry.

Dr. Clarke commented there's a continuum between doing something to learn something and doing something to show success. As the pendulum swings back and forth, there is a struggle in that many in the emerging UAV/UAM market have the mindset to go and build something, test to see if it works and learn as you go. NASA Aeronautics must decide where it sits on the pendulum, then commit itself to that direction.

The Committee suggested UTM providers might follow a cable model in terms of dividing services over a particular geographic area. Multiple UTM providers operating over the same area could introduce operational difficulties and safety considerations.

The Committee asked about the inclusion of access to space as part of the UTM/UAM autonomy model NASA Aeronautics envisions. The answer: Convergence of technology, autonomy, electric, etc., are not as prevalent in an area such as supersonic, which is not part of the model. In the same way, access to space – commercial or otherwise – is not part of what is being considered in this area of research.

Dr. Clarke suggested a change in viewpoint, looking ahead to a time when UAS operations are more common than commercial aviation flights – similar to the way space launch operations' impact on the National Airspace is much less frequent than commercial air traffic. There may be some interesting synergies in terms of how a solution develops.

Mr. Borghese asked for more clarification about the charter and operations of the vMDIO. Mr. Pearce offered that, among its duties, the vMDIO would do fundamental market studies (contractors already are actively doing this) and based on the results ensure that ARMD resources among its programs and projects are aligned and prioritized in a logical way.

There was much discussion about the timing and content of deliverables for the two contractors doing the market studies, and concern expressed that 12 months is too long to be getting this information back considering how fast the market is changing. NASA must be ready to be flexible depending on the results, and continue that flexibility should these studies become out of date.

Dr. Ducharme agrees that the virtual mission development integration office is an excellent way to work in this area.

The Committee indicated that this area is changing fast – reminiscent of the N.A.C.A. days 100 years ago – so NASA has to work out not only what are the technologies, how to make flight safe, what are the regulations, all those areas are dynamic and they're changing dramatically.

Dr. Clarke added that no matter what the future holds, NASA must be able to articulate the key things it is working on and how it can make an impact.

Dr. Clarke also indicated that NASA must be able to answer this whole idea of what is autonomy. Is it autonomous operations? Or is it autonomous decision making?

Committee members expressed a desire to see modifications to the way the two market studies are being conducted. Timing should be harmonized (perhaps at six months) and a potential debate of sorts between the two views should be considered – a red team, blue team approach in which the resulting output is something like purple.

Dr. Ducharme suggested to do an analysis of the key things needed to enable this future and clearly identify what NASA's role is based on core competencies, working with partners, etc.

Dr. Clarke suggested to look at the issue of autonomous operations, which is decision making, and what NASA needs to address.

The Committee added that as it relates to decision making in terms of necessary research activities, determine what is uniquely aerospace, or inherently in the purview of NASA/government, vs. something more general.

RECOMMENDATION

The Committee agrees that the NASA research in autonomous vehicles and autonomy is important for the U.S. Because of new technology, market demand and industry investment, autonomy and autonomous vehicles could change aviation similar in scope to the birth of aviation. Because of these dynamics, the Committee agrees with the approach to have independent evaluations of the autonomous vehicle market and recommends that NASA harmonize the two studies so that they have the same time frame to get more value added.

Given the fast moving space of these new entries and the uncertainty they bring to aviation, the Committee also recommends that the NASA Aeronautics Research Mission Directorate (ARMD) identify issues and gaps that need to be addressed regardless of the studies' outcomes.

Major Reasons for the Recommendation

Currently the two studies are in a different time frame – 4 months vs. 12 months. The thought is that there might be some sharing of information and discussion of outcomes that will be beneficial for NASA to balance areas off each other during the study.

Consequences of No Action on the Recommendation

The studies will lack the benefit of a healthy discussion on any differences in outcomes. If the studies result in different outcomes at different time periods, there will be uncertainty on which outcome should be used for NASA technology investment.

5. 2018 Work Plan & Schedule Discussion

The NAC Aero committee will meet three times in 2018. Specific dates and locations will be announced.

NASA Aeronautics managers appreciate the NAC Aero Committee's interaction and comments. This maintains the desired role that the NAC Aero group operates as an advisory committee, providing guidance based on their broad areas of technical expertise and experience.

NASA Program Directors appreciate the NAC Aero committee's willingness to be briefed at a high level that speaks to major goals, strategic research thrusts and broad topics as opposed to detailing every nuance of a specific project. This is helpful as the Committee's system-level perspective directly aids in planning the direction those project details take.

The question was asked of the Committee "Are we giving you the information in a way that allows you to make your assessments and provide back your recommendations in a way that is consistent with the full picture?" The responses were complimentary.

Among the relevant comments made by committee members:

- The presentations that we receive are consistently excellent.
- The work that you're doing is the right type of work that NASA should be doing for aeronautics.
- This is not a technical review. This is a strategic review of NASA's priorities, plans and accomplishments.
- Having the opportunity to tour the Centers or view some demonstrations before the meeting helps prepare members to provide the right level of comments during the presentations.

The Committee was asked if a future briefing detailing how NASA Aeronautics works with its various partners to coordinate, collaborate and transfer information at a high level – such as with Research Transition Teams – would be beneficial. The answer was positive.

A suggestion was made to ensure that when public demonstrations, media days, etc., take place to showcase NASA Aeronautics technology, committee members are invited to witness the activity if their schedule permits.

6. Public Comments

There was one comment from a member of the public indicating that the presentations were well structured, very informative and gave the Committee an opportunity to understand what NASA's strategy is and comment in a way that NASA can take that information and have a better outcome in all their pursuits.

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List of Attendees:

Name	Affiliation
John Borghese	Committee Chair
John-Paul Clarke	Member
Eric Ducharme	Member
Karen Thole	Member
Irma Rodriguez	Committee Executive Secretary
Jaiwon Shin	NASA ARMD
Jon Montgomery	NASA ARMD
Bob Pearce	NASA ARMD
Ed Waggoner	NASA ARMD
Jay Dryer	NASA ARMD
John Cavolowsky	NASA ARMD
Starr Ginn	NASA
Dana Gould	NASA
Ruben Del Rosario	NASA
Paul Krasa	NASA
John Koelling	NASA
Brad Flick	NASA
Jessica Nowinski	NASA
Steven Schmidt	NASA
David McBride	NASA
Carmen Arevalo	NASA
Lee Olson	FAA Liaison to NASA
Steve Spearman	FedWriters
Peter Iosifidis	Lockheed Martin
Jose Hernandez	AERO Institute
Mike Beavin	NASA - Webex – remotely
Andrea Storch	Webex – remotely
Akbar Sultan	NASA - Webex – remotely
Darrell Branscome	Webex – remotely
Unmeel Mchta	Webex – remotely