Research, Engineering and Development Advisory Committee (REDAC)

May 26, 2016

Meeting Minutes

Federal Aviation Administration (FAA) National Headquarters
10th Floor Round Room
800 Independence Avenue, SW
Washington, DC 20591

Note Taker: Dennis Flath

09:00 am – Welcome and Opening Remarks
Shelley Yak (Director, FAA William J. Hughes Technical Center) (REDAC DFO), and Dr. John Hansman (REDAC Chair; Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology)

Shelly Yak opened the meeting reading the official notice and charter. She welcomed the Advisory Committee, Subcommittee Chairs, Research Executive Board (REB) members and Designated Federal Officials (DFOs) for their knowledge, experience, and insight; and their commitment to step away from current responsibilities, fully prepared and ready to discuss FAA research activities.

Having attended the Subcommittee meetings, Shelley observed quite a few potential best practices and is desirous of bringing those across the subcommittees. She requested that Subcommittee Chairs help by having dialog with other committees in identifying what works best in their area, and help her be more efficient and effective in the future among each other.

Shelley identified an area of opportunity to have more dialog and understanding between REDAC and the FAA. As a consequence, today's Agenda included discussion time built in to permit an opportunity for exchange for full engagement and a better result of recommendations and questions, and effective FAA responses and clarifications.

Dr. John Hansman expressed the intent of REDAC to help FAA formulate their R&D plans and strengthen their position, especially with respect to Unmanned Aircraft Systems (UAS) which was the focus of the morning session.

09:15 am – FAA Administrator's Address
Michael Huerta (Administrator, Federal Aviation Administration)

The Administrator extended a greeting. He stressed that he wanted to share what the FAA was doing, in particular with "all things UAS", recognizing how it fit into a larger framework. He stressed that industry was rapidly evolving and that few anticipated the growth of the past 2-3 years. This expansion was clarifying the relationship between the FAA and industry. The FAA is faced with challenges of privacy and national security, and even defining vertical airspace. Lastly, he thanked the REDAC for their time, insight and contributions.

09:30 am – FAA UAS Overview and Perspectives
Marke Gibson (FAA, Senior Advisor, Unmanned Aircraft Systems)

Marke Gibson provided an introduction and a brief resume. Prior to joining the FAA, Marke served as the Executive Director of the NextGen Institute (NGI); he retired in 2011 as the Air Force's Director of Current Operations and Training. In that role, he also worked on behalf of the Secretary and Chief of Staff of the Air Force on ways to better integrate UAS in into the NAS. He now holds the position of Senior Advisor, Unmanned

Aircraft Systems Integration reporting directly to Deputy Administrator, Michael Whitaker. Marke introduced Bill Crozier (Deputy Director, FAA UAS Integration Office).

> *Note: John Hickey, Deputy Associate Administrator for Aviation Safety (AVS-002) was also a significant participant during this session providing clarification, background and additional insight on these matters to the participants.*

Bill Crozier provided the UAS Overview and Perspective. The first priority is to get all of FAA on the same playing field and same priority of UAS integration, not always an easy task, but there has been a lot of progress over the last 6-8 months in strategy, planning, with an increase in technical effort and pace. Although, FAA has accomplished much, there is more to do and FAA must remain flexible and adaptable. There is a new aviation community with growing commercial interest, low-cost entry, and many more members where "everyone wants in".

Bill presented charts *(Slides 4 – 7)* emphasizing the spurt of growth. The volume of the traditional aviation has remained fairly flat over the past 20 years. New entrants (UAS from .55 – 55 lbs.), registering through the website from December 2015 to April 2016, averaged three registrations per minute or approximately 3,800 per day.

Committee members inquired about FAA's tracking of demographics and categories of the registrants. FAA has captured information by state and county. Information is now available online at the county level, but it may not be a true reflection of the number of drones given that one person can register multiple aircraft under one listing. Asked about prediction for the next six months, Bill's slides reflected a five year forecast and an economic analysis of projected sales, but also acknowledged that every year starting in 2004 or 2005, the FAA has underestimated the numbers. The chart featured both 'Low' and 'High' forecasts with a significant variance to which Bill stated that the *"reality is somewhere in here"*. Responding to a question, Bill explained the "Special Rule for Model Aircraft" Section 336 whereas references to commercial users tend to be in a higher weight group.

Bill amplified on FAA UAS Activities *(Slide 9)* identifying responsible functions and groups to: 1) Manage NAS Access, and 2) Provide Minimum Standards with particular emphasis on Part 107 Rule and expansion of the UAS Executive Committee (ExCom). An active exchange resulted with discussions on NAS access, connectivity of the functions and groups, and ultimate responsibility. The Chair posed a hypothetical scenario of Google changing direction and proposing a long endurance, internet-related vehicle above 55 lbs. that flies at 18,000 feet, and doing what it takes to get the vehicle certified. He inquired if "*the FAA (is) willing to accept an alternate communications path – a landline – as a backup*"; specifically low-altitude class, integrated Concept of Operations (ConOps)? Dr. Jaiwon Shin (Associate Administrator, Aeronautics Research Mission Directorate, National Aeronautics and Space Administration) interjected that NASA has conducted a study over the past 5 years on that class of aircraft. John Hickey cited work conducted by the Center of Excellence (COE) on UAS and their modeling research on UAS hitting targets such as vertical tails; as data is gathered and will inform the FAA better.

Dr. Steven S. Bussolari (Chair: Subcommittee on NAS Operations) remarked that the FAA UAS Concept Maturation Plan was briefed to the NAS Ops Subcommittee meeting last fall (2015) and considered it a good framework. However, one of the comments was that the Plan hasn't been shared with the broader communities, and therefore the media lacks the understanding of the complexity of the problem and they don't see how the Plan is formulated. John Hickey responded that several of the FAA's plans are still under review.

Slide 10 (Managing NAS Access) was present outlining 'Risk/Complexity' and 'Functionality Over Time'. The Chair expressed confusion about what the content was attempting to convey – it's not a coherent picture. John Hickey walked the Committee through one of the elements and the Chair stated that he fully understood the words, approach and concept – different classes with different challenges. He suggested that this chart is likely a communications problem; proposing that want is needed is a better, coherent framework. It would be better to state what are the real challenges, what information we need and, once we understand the questions, we can assist in defining the research.

Steven Bussolari reiterated the question as to how FAA communicates with outside users, what the game plan is, do they have a realistic expectation of what's coming. The Committee asked if the 425,000 users (web registrants) are 'happy out there; do they see progress'? Bill Crozier noted that he recently attended an Academy of Model Aeronautics (AMA) meeting and they weren't completely onboard.

The next chart (Slide 11 – System Safety – The Safety Continuum) addressed the extent of safety from too little rigor to too much rigor. John Hickey stated that FAA does not have a risk-based model of a UAS hitting an aircraft. John Hansman, mentioning one of the upcoming recommendations, stressed the importance of exposure data and that there is information coming into the system. Is there a plan to develop a process to archive that data to get operational failure experience to form a basis?
Bill Crozier talked about making sense out of unmanned commercial versus private. There is not a formal risk assessment, but is based upon a certain set of assumptions. This slide indicates that with less demand, there is less rigor, but as UAS traffic moves up in size and complexity a rulemaking approach will apply. When Rule 107 comes out, it will have certain limitations. Societal acceptance of risk, public level of safety was discussed with examples of power-line personnel impacts versus the same number of people being hit on the ground and possible mitigation. FAA is taking the next step, currently in the process of developing a rule having to do with flying over people.

Pathfinder operations have laid groundwork; CNN working on ops over people, PrecisionHawk working on extended line-of-sight, such as agriculture; and BNSF railway and Beyond Visual Line of Sight (BVLOS). These kinds of operations will allow FAA to be better informed of what some of the challenges and what some of the unknowns are.

Marke Gibson addressed the need of data for rulemaking and the foundation for next step beyond line of sight. These operations are designed to push the envelope so we have additional data. Responding to a question, John Hickey stated that he wasn't sure if the BNSF data was publicly available. John Hansan reiterated that the theme here is although things may be happening; from the outside you can't see it. Steven Bussolari: Pathfinder is a great way to go, and assuming they are successful, but how will airspace be allocated – first come, first served – creating these tubes of airspace? These issues could be worked today.

With respect to "Developing Operating Standards" (Slide 14), the plan is to expand the use of waivers and creating provisions. The next two slides addressed "Key 2016 Milestones" and "Key 2017-2018 Milestones" are intended at a high level and do not reflect an actual work plan for those specific efforts. Ken Hylander (Chair: Subcommittee on Aircraft Safety) noted that nowhere in the milestones is a reflection of a Strategic Plan being released to the public. John Hickey assured the Committee that they would be – when finalized and approved.

Reacting to a discussion about milestones, a draft strategic plan and a vision for public release of documents, John Hansman stated that in discussions with Administrator Huerta the way in which REDAC could assist would be to help the FAA think about critical path issues and articulate key research areas that need to be addressed.

Continuing the briefing, Bill Crozier and John Hickey addressed issues of budget assessment and the relationship between the Strategic and Implementation Plans with respect to other lines-of-business, and how best to approach Congress. Every year since 2005, the FAA underestimated the needs to support UAS. The FAA didn't have a UAS budget line item until 2012…FAA absorbed it in the intervening years.

John Hickey remarked that it is his understanding, not necessarily a fact that safety is suffering in specific areas as a result. The FAA would welcome input from REDAC if they see otherwise recognizing that the FAA is underfunded in both R&D and F&E. *"We're moving money from one pocket to another to feed the UAS monster."* We think the time is now (for requesting additional funding) since UAS has the attention of everywhere; in his 36 year career he's never seen an issue that has grown as fast.

The discussion progressed as REDAC and the FAA agreed that UAS needs to be an elevated priority across the entire organization. The impact across the agency should be accessed: training, manpower, resources and more. Mention was made that although representatives from ATO were not present, they have been contributory, and are

involved in exercises and that some slides presented today were a product of ATO's input. Additionally, although FAA is to provide guidance, industry is helping to develop plans through a diversity of constituents such as Walmart, and Intel. However, FAA will still require resources, focus and coherence and more advocates…having more constituencies outside that are supportive.

Lastly, John Hickey noted that authorizations on the Hill (prescriptive) are not necessarily helpful; look toward Australia and Europe (such as JARUS – Joint Authorities for Rulemaking on Unmanned Systems)

10:15 am – Chairman's Overview – UAS Findings and Recommendations
Dr. John Hansman (REDAC Chair; Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology)

REDAC has requested, received and reviewed "Deep Dives" into Unmanned Aircraft Systems. As a result, the first point is in some sense one of a communications issue and one of a structural issue; the overall UAS integration Strategy is not there, there are pieces which have been done, but haven't been communicated outside. Even the (2012) ConOps wasn't release but was available on an FAA website, but *"is hidden somewhere that you need to know about"*…this is symptomatic. The community doesn't know what to do, what research has been or needs to be done in order to support the mission, and a related issue of architectural issues or assumptions – as an example: what are the surveillance options, not necessarily what are you going to do, but what are you considering. You need *'to get the message out'*.

REDAC is happy to see the FAA moving; for a long time it appeared there was 'lip service' (example: *"we're going to spend a year studying test site needs"*)John said, "Now you are moving forward. It is still concerning when we hear that the Agency is going to form another advisory group, another study group or executive committee that they are doing this but we can't tell you what they are saying. So again, that's why you need to get the message out."

"As a consequence of that, from the outside and even from the inside, the research efforts appear piecemeal and not coherent; activities that pop up just don't seem to make sense, you can't make out the path.", according to John.

John continued stating, "We believe that you're absolutely right in making a risk-based approach. There's now an opportunity to gather data to support a risk-based analysis with a level of rigor for a number of certifications. Pathfinder programs are great; but there must be a 'learned lessons' from that and communicate what you are learning. It appears from the outside that there are still some detractors about Pathfinder."

A top urgency of concern needing to be tackled on the short term is medical service helicopters and how to mitigate the impact of UAS. People are monitoring frequencies and events and UAS operators are coming into 'hot zones'. Think about what you can do to support them.

We are not concerned about airworthiness, but we are concerned about air traffic…although we're not in that business, but a concern is air traffic integration and that is missing in the plan. It may be as simple as defining a set of standards and communicating that so they could move forward and operate.

We are agreed about the concern that the UAS focus may dilute other areas. Articulate your needs in parallel in the same high level of strategy and not parse your UAS strategy as its own but how it fits in overall. On the environment side the issue is one of noise that the rules did not anticipate. On the human factors side, some of the issues will be training, certification, and so forth, but you can't just port the existing rules over because it's too simplistic. There are issues of design interface, procedures, etc. – there may be gains to be made through the military experience.

10:45 am – *Break*

11:00 am – UAS Discussions – REDAC Chairs and FAA Executives
Dr. John Hansman (REDAC Chair; Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology)

The Chair, Dr. John Hansman opened the floor for discussion following the presentation "UAS Overview and Perspectives" and Chairman's Overview – UAS Findings & Recommendations.

Steven Bussolari noted that most of the prior discussion was about budget and allocation of funding and heavily emphasized airframe certification & airframe safety, and much less on integration and procedures from an operations standpoint.

John Hickey noted that FAA is doing virtually nothing or tiny fraction of the budget (1 percent) on certification or airworthiness approvals. The new UAS budget line item is focused on the UAS Integration Office and other components in the agency and is in no way focused on certification or approvals of these aircraft.

The Chair reiterated the Committee's concern that although there is a line of activity having to do with the infrastructure; no one appears to be doing research about operational procedures and policies.

It was noted that last fall the committee received briefings on the development of operational scenarios, completed the requirements derivation, the concept maturation plan and seemed to be sound work and a systematic approach. But it was not visible to the community. There is a challenge of transparency, of how solid the information is and that it's not just about the research that the FAA needs, but it is also what research the commercial side needs as well–other requirements such as sense-and-avoid, loss of communications and those kinds of things.

(ACTION Item) A question was raised about the location of the FAA (ANG) 2012 report on *"UAS Integration into NAS ConOps"* not being available, transparent and a concern that it might be restricted. The FAA took the action to locate, assure that it wasn't restricted and distribute the subject report.

John Hickey shared the observation that it has become clear to him that R&D has to have input coming from industry since they have the view of what's coming 2-3 years from now. FAA does not have any kind of model that; the FAA will be using the COE for that. His immediate concern is a drone being ingested by an engine; FAA does not yet have a model for that.

Jack Blackhurst (Chair: Subcommittee on Human Factors) stated that human factors research for UAS is nonexistent, but that there's enough current knowledge that solving current issues would not require a great deal of research – just take those challenges on, draft them and get material out. John Hansman contributed to the discussion suggesting that there are probably a set of human factor issues that should form a structure or baseline that's not policy, but forms a working agreement with the community; thereby establishing a path or a series for the different classes. Bill Crozier asked if REDAC were to suggest a recommendation list for the FAA, how they would prioritize research for human factors. John Hansman responded with a broad list of examples but focused primarily on how 'manned' controllers will interact with UAVs and using the military procedures or best practices. Currently, their procedures vary based on location wherein manned aircraft take priority over unmanned or vice-versa. Air traffic controllers react to higher performance vehicle versus lower performance. The question needs to be asked or researched as to which of these are appropriate to cross over to NAS.

The Committee again stressed that their observation was that much work has been done but research has not been shared, not even in draft form. Ken Hylander commented that energy should be expended now on data collection thinking about what data is needed 5 – 10 years from today; especially with over 425,000 registered units flying around the system and the existing commercial airlines database. John Hickey agreed, but wanted to build the

case for doing so since he has little confidence in the current set of data because the recording systems on planes for this are not reliable at all (example of bird strikes vs. drone hits).

As a last point, the Chair reiterated that in his discussions with the Administrator, REDAC was asked to help over the next year and identify the critical research areas and the way forward. REDAC would like to go deeper into the ConOps assumptions and help identify and validate the needed research, and take those discussions to the Subcommittees and then loop back. The remainder of the exchange concerned potential areas, involvement of airports and a return to the earlier discussion of risk analysis as a high priority.

The UAS portion of the meeting closed with an acknowledgement of the benefits of holding this open and frank discussion and is helpful to the FAA.

11:45 am – NASA Report – NASA Aeronautics FY2017 Budget Request
Dr. Jaiwon Shin (Subcommittee Chair) (Associate Administrator, Aeronautics Research Mission Directorate, National Aeronautics and Space Administration)

Jaiwon Shin shared rationale, background information and his perspective on the previous years' work and the unexpected and unprecedented budget increase. He was excited by the outlook and pleased to share this presentation with REDAC, FAA's most important civil-side partner. NASA had been working aggressively on environmental aspects and reflected on the new White House initiative "21st Century Clean Transportation System", having received numerous piecemeal requests from OMB. At the end of year, NASA received a plus-up and was grateful to be part of the initiative working with communities in developing and maturing the technologies to reduce fuel consumption, emission and noise.

NASA rolled out a long-term strategy in 2013 in six thrust areas: 1) Safe, Efficient Growth in Global Operations, 2) Innovation in Commercial Supersonic Aircraft, 3) Ultra-Efficient commercial Vehicles, 4) Transition to low-Carbon Propulsion, 5) Real-Time System-Wide Safety Assurance and 6) Assured Autonomy for Aviation Transformation. The first three have been ongoing and steady investment. 4 through 6 are new, key technologies and emerging needs in the transportation community. These have been enthusiastically embraced by committees and communities and are necessary to advance state-of-the-art getting ready for the next two or three generations for aircraft systems and air traffic management. Numbers of studies of have done since 2008 with industry and academia with steady investments in those key enabling technologies.

When assuming his position, Jaiwon's recommendation was to return to the X-Plane mentality and that research method; however, resource funding has been scarce. We now have a golden opportunity for aeronautics study and NASA is going back to 1.2 billion budget request per year. The difference between earlier requests and now is that this contains only aeronautic concepts – it doesn't have anything else. It has air space operations and safety, advance vehicle technologies, and integrated aviation systems through X-Planes and concepts for transformative future innovation.

Excited by both, House and Senate appropriations committees expressed what they would like to do with the NASA budget. NASA is still unsure about amount of plus-up ($600 to $712); hopeful that House side will win out. In any case, if they get the whole budget request, it will amount to 10.6 billion for 10 years. Office of Management and Budget (OMB) only allows 5 year budget request; this year NASA was only exception in entire federal to show 10 year budget to Congress. In Dr. Shin's opinion, this indicates that OMB recognizes and acknowledges that development of to design, build and test an experimental aircraft – in this case, a series of aircraft. Based on receiving that full budget, NASA should be able to build one supersonic flight demonstrator to measure sonic boom and measure public perception for acceptance; then three different types of subsonic demonstrators. The hybrid model would be a technology collector that would test and evaluate a myriad of technologies conveying the message that we are not in the prototyping business but rather using these configurations to test and demonstrate the intended benefits. The other two are lower-cost, purpose built designed to test one or two key technologies. Lastly, the other vehicle would involve electric propulsion which currently is in its' nascent stage; we would study on the small scale, learn from it and scale up according.

Jaiwon spoke to *"Trajectory Based Operations: Concept to Demo"* (slide 7) discussing work approached, underway and planned through 2020 on the air traffic management side transport technologies to help terminal area operations –demo, test and validate – to be safer and more efficient. Other demonstrations are planned, trajectory based operations, in close cooperation with ANG through simulation and human-in-loop studies and flight demonstrations and invest more (about $300 million) if the full budget is approved.
Some five years ago, NASA initiated UAS integration into NAS project with $30-35 million a year ending at the end of this fiscal year after a six-year run. Jaiwan stated, "We thought that large, sophisticated UAS integration into controlled airspace at low altitude was the key important lead to take, but 2-3 years ago it became apparent that it was the small UAS operations at lower altitude was a real thrust of community interest. So we started UAS traffic management project 2 years ago growing to $18-19 million investment per year; we will continue for 3 or 4 more years at that level. But I have a concern about whether we have silos here. Although driven by good motivation and intentions, we have two different projects in two different programs. So with the new budget formulation, we are mandating that all NASA personnel working in UAS to develop integrated research plan."

The Chair inquired if there have been outcomes and passed to the FAA. John Hansman asked, "Why aren't you doing more on UAS technology development? Are you developing MOPS for areas that are in the ConOps? Understanding that everything is integration, and it is urgent, but the hottest area in aeronautical engineering worldwide is UAS development and the biggest producer of UASis Chinese. Why is NASA notdoing more in UAS vehicle technology development, into control systems and interfaces and such?"

Jaiwon replied that they have worked in "Manned like" IFR (Instrument Flight Rules) MOPS (Minimum Operational Performance Standards) development in the areas of detect and avoid, and communication areas with the FAA, "The $35 million per year is not 'chump change' given the $640 million yearly budget, so we try to maximize the impact working through the RTCA and FAA. We thought that developing from enabling technologies as reality was more important than vehicle technologies because there are tons of players out there."

John Hansman cited a number of issues such as noise, aerodynamic issues that are new and emerging, flight control issues, "It seems you may have missed opportunities."

Jaiwon replied that they are investing and he has directed that vertical lift expertise they have, rotorcraft and electrical propulsion personnel to work with other disciplines to address some of the autonomous issues. The chances of getting into other areas are pretty high.

James Hileman (FAA, Chief Scientific and Technical Advisor for Environment and Energy, and Program Manager, Center of Excellence for Alternative Jet Fuels and Environment), contributed that previous FAA experience is that noise concerns will definitely add to the challenges. James stated, "Having talked with NASA Langley, it is nearly impossible to get noise measurements on systems, but there is a potential opportunity to get ahead of this since you do all the open source codes; you have all the right equipment and people."

Jaiwon Shin agreed and noted that this important research has already been directed but is coming slow; with the current budget limitations they normally have to wait for displacement of projects underway to make room. However, with an increased budget as requested they can speed up research in these and other areas.

01:00 pm – Subcommittee Report – Aircraft Safety
Ken Hylander (Subcommittee Chair) (Chairman, Flight Safety Foundation)

The Spring Subcommittee on Aircraft Safety (SAS) was held in March at the FAA William J. Hughes Technical Center in Atlantic City, New Jersey. Per Ken, "We had 4 main deliverables from that meeting: 1) Reviewing UAS Research Priorities, 2) to review the FY18 Research Portfolio, 3) 2014 Emerging and Future Issues assignment (we keep these front and center to keep our focus on discussions to be sure we're on the correct issues, getting smarter and do we need to fine tune them), and 4) provided input on the (AVS) FY19 Research Guidance Document."

Ken noted, "Items 3 and 4 actually merge together because this ensures that these are the research areas that REDAC feels is important. We continue to build upon the work of prior SAS meetings and involve Chief Science and Technical Advisors (CSTAs), industry and FAA experts as participants as much as possible. We make it as broad as possible including manufacturers, pilots and airlines and build numerous interfaces with them. We have taken deep dives into significant items and look at research dollars committed, REDAC's priority items, and concerning items or emerging technologies."

Ken further stated, "For this particular meeting, we had the full REDAC request to hold a UAS discussion; and as an emerging issue, a detailed briefing on breakthrough medical technologies on FAA medical certification standards. What are medical breakthroughs permitting people to fly, and what is limiting them from doing so – such as drugs? An example might be depression – for instance, what approved drugs permit certification to fly. We don't fully understand some of those and the implication of drugs like anti-depressants. We do have Dr. Crowley from the Army Medical Team and he is working hard keeping us educated as we cover these topics and the work of CAMI (Civil Aerospace Medical Institute)."

(ACTION Item) Provide the detailed write-ups and recommendations of UAS Discussions from SAS that did not make it into the binders.

Ken added, "The Subcommittee continues to be concerned about Additive Manufacturing Certification; it's the third time its' been a finding. It clear that there's activity happening, there's a roadmap being developed, a certification policy memo and a tactical project plan (that's probably the day-to-day working being done). The Committee feels that the work needs to be pushed, work faster to give the support to the certification folks to help make the decisions on additive manufacturing. We're requesting research and development provide the aircraft certification office the guidance needed when parts proposals go to the FAA to approve them."

John Hickey pursued this thought stating that there is the emergence on additive manufacturing in the community (General Electric for example) and there are already approvals on approximately 20 non-critical parts have been certified. Dr. Michael Gorelik (CSTA, Fatigue and Damage Tolerance) has developed training, and development and certification policy with respect to two plans (composites and icing). John added, "I will ask that Michael finish his roadmap plan. We've been pushing to see a roadmap, and we haven't seen research dollars designated for Additive Manufacturing research yet. "

Mike Gallivan (Manager, R, E and D Financial Management) responded that for '16-'17-'18, money has been designated.

Mike emphasized, "With respect to Advanced Materials, we're looking for specific information in the research plans related to propulsion systems; work on materials and non-destructive evaluation techniques. During the meeting, we discussed issues regarding hot corrosion on engines, advanced non-destructive evaluation, fatigue and modelling in titanium and computational material science."

Mike further added, "The last was Ice Crystal Icing (ICI) Engine Test; viewed as an important issue – how to avoid environmental conditions that could create it, but the committee feels it's important work, but may not be

100% practical that you can avoid it so you better understand it and figure it out. Some engines appear more susceptible than others. This is an area that needs to be kept alive."

Dr. Jaiwon Shin injected that this is a big emphasis on aircraft icing that NASA is also working on.

Ken wrapped up by informing REDAC that the Subcommittee made the decision to hold a future meeting at CAMI and a meeting at Headquarters.

01:30 pm – Subcommittee Report – Human Factors

Jack Blackhurst (Subcommittee Chair) (Director, Human Effectiveness Directorate, 711th Human Performance Wing)

Jack Blackhurst reported that the Subcommittee on Human Factors held their meeting at the Civil Aerospace Medical Institute. He stated, "Every session we pick up new topics; this time we covered Manned Commercial Space Transportation, and tracking Data Analytics work by NASA Ames on operational data to see if there's an identification of unique anomalies that might be useful to us; data that could be passed back to the aircraft. We also focused on UAS and brought in Air Force and the NASA Ames teams and what they were doing and operational control stations."

Jack continued with, "We also focused on UAS and brought in the UAS folks from NASA Ames and the Air Force to see what work they were doing as a unique opportunity to see who else is working in operational control displays of UASs. We also had representation from the Center of Excellence on UAS; by telephone, Ellen J. Bass from Drexel University (Professor and Department Head of Information Science, College of Computing & Informatics) who is involved in the Human Factors arena. We wanted to understand how the work of the 21 universities interface and coordinate with researchers at the FAA. We explored funding issues as to the Congressional levels and whether the FAA will continue to fund them in 5 years; no one knew the answer to that."

Per Jack, they have had five Findings and Recommendations:

1) In the ATO arena the HF people assembled a roundtable of stakeholders and organizations with the intent of prioritizing HF research needs within the ATO. The Subcommittee recommended that the process be more formalized, influence budget cycles and consider categorizing into short and long-term needs.
2) With respect to FAA FY18 UAS Human Factors Research, the Subcommittee recommended that CAMI conduct expert workshops to develop UAS baseline guidelines for human factors issues which could produce a document for the field in short order which wouldn't require a great deal research.
3) The Subcommittee explored whether the methods of training for pilot performance are effective given the automation now in the cockpit. The recommendation was that FAA identify pilot knowledge and skills for the current and new flight systems operated under NextGen, and identify a process for defining the requirements, training devices and training methodologies.
4) The Subcommittee felt they didn't know what the FAA top priorities are for research. The recommendation that Shelley Yak, as Director of Research, should produce a document to that extent (perhaps the top five) that would be helpful for all the subcommittees.
5) The Subcommittee felt that the impact to reductions in the budget are not well understood; researchers should be clear about what the overall impact will be if the research is not conducted to priorities and planning.

01:45 pm – Subcommittee Report – NAS Operations

Steven Bussolari (Subcommittee Chair)(Technical Advisor, Air Force Rapid Capabilities Office)

The Subcommittee also focused on UAS issues, and the Subcommittee's Findings and Recommendations have for the most part been covered here this morning. Steven noted, "We reviewed nine budget line items in our area. On the second day, we were hosted at NASA Headquarters and received an overview by Dr. John Cavolowski (Director, Airspace Operations and Safety Program, NASA Aeronautics Research Mission Directorate) on the Aeronautics' portfolio."

(Action Item) Steven inquired about not having received the Administrator's response to the previous set of Findings and Recommendations; specifically prioritization of runway incursion technologies. Re-cap: There did not appear to be cost-benefit analysis across runway safety techniques – no benefits pool to make determination of feasibility or cost-estimates of low cost technologies.

To wrap, Steven reiterated that both the Fall and Spring meetings were largely about UAS and UAS integration in the NAS and the resulting NAS Ops recommendations.

The REDAC Chair inquired about simulation study in Florida that didn't seem to make sense. Bringing everyone up-to-date, Steven reminded the Committee of a simulation in Florida (Embry-Riddle) demonstrated of 4D trajectories and that the Subcommittee had concerns that it was fairly large but it was not clear that data was being collected; it did not appear to require the level of money and effort, questionable ROI (return on investment).

The action was to submit back to Subcommittee research rationale, received last week, and upon review still appeared rather thin on details.
(Action Item) Shelley Yak requested that the delegate or CFO get back to the Subcommittee before moving forward.

01:50 pm – Subcommittee Report – Airports
Dr. Christopher Oswald (Subcommittee Chair) (Vice President, Safety & Technical operations, Airports, Council International – North America)

Much of the Subcommittees' focus was on budget issues and projects focused on research areas. Christopher said, "Since we were looking at the project level it was hard to get a sense of where the allocations were, whether it is safety, pavements or planning. So we looked at high level tracking over time and whether we're coming to completion but that came with compromises."

Christopher further stated, "Because there were a couple of proposals for capital improvements on the pavement test facility since we're approaching the physical lifetime of that center and a number of expansion requests for project work, we're asking that capital program planning or maintenance rehab life-cycle plans be generated. This is primarily because the research programs don't capture those capital expenditures."

John Hansman urged that in the next cycle the Subcommittee should stay away from capital improvements as that's not REDACs' role; it would better to that Michel Hovan and Shelley Yak explore why a particular capability is critical. Christopher noted that the subject came up because the Subcommittee was asked to evaluate the additional requests beyond the program budget, and consequently inquired what kind of major expenditures over the next 3 or 4 years would limit research.

The Chair (to Shelley Yak) recommended, once again, putting together a high-level research strategy; a way to connect it all together – not just R&D, but F&E as well. John cited the Environment and Energy Subcommittee as being the most coherent and cohesive. Shelley injected that it is all part of best practices that she hopes to bring to all the groups and is on the docket.

Christopher continued by commenting that Pathfinder 4 has the interest of the airport community and shows focused research; but the problem becomes uneducated or ignorant operators in the zone. Detection problems are paramount and the challenge is false alarm resolution; every bird could be a target. The value of Pathfinder 4 was discussed among REDAC members. John Hansman expressed concern and would prefer a more nuanced approach to recommending Pathfiner 4 specifically, and address the recommendation to do system level analysis to determine technologies such as Pathfinder 4 could or should be implemented.

Lastly, Christopher talked about the concern of runway safety issues and how the FAA has prioritized airports for Runway Incursion Airport Assessment Program, although important but narrowly focused on the safety side. It appears to proceed independently of other airport safety programs and airport operators are not necessarily 'seeing

under the hood' and prioritizing it in the 5-year CIPs (capital improvement plans). He added , "We're looking to making that information more widely available and for an alignment with the Runway Safety Council."

02:40 pm – Subcommittee Report – Environment and Energy
Mahendra Joshi (Subcommittee Chair)(Chief Engineer, Noise & Emissions, Boeing Commercial Airplanes)

Mahendra spoke to ICAOs' (International Civil Aviation Organization) adoption of CO_2 Emission Standards; what made this happen were largely the validated five pillar strategy, including tools and policy) adopted for the E&E research, engineering and development program. This approach demonstrated the U.S. global leadership role in ICAOs' environmental agenda.

The Subcommittee developed four Findings and Recommendations:

1) It was shown that intra- and inter-agency collaboration in defining and executing the portfolio achieved robust results. It is therefore recommended that although much has been achieved collaboration should continue both within other departments of the FAA, other agencies and internationally.
2) The CLEEN Program matured technologies for product insertion. This too demonstrated continue collaboration between FAA, Environmental Protection Agency, the Department of Energy, and the Air Force with continued commitment. Everyone brings strength and should be encouraged and commended as well. The Subcommittee recommends continued commitment; it's high value due to a greater than 1:1 cost share. CLEEN 2 Program, a follow-up, is setting up a portfolio that is well balanced.
3) Research tasks were defined and implemented in a Noise Roadmap and is making good progress. A survey was conducted on noise and health; elements of sleep disturbance, and annoyance and health. We're attempting to understand the noise impact on communities and developing measures. This necessary to understand the impact on community, perception, and understanding when policies need to be changed. We recommend continued support and collaborative analyses of the collected data, and lastly,
4) Because UAS is likely to have an environmental impact, we recommend the development of a plan to access and understand the impact – especially noise. We wish to focus on opportunities to gather data, especially in cooperation with NASA, so that we can evaluate to determine how big a problem it will be.

James Hileman provided additional comments giving special recognition to the collaboration with NASA; work with Langley on UAS noise issues and leveraging everything we can. James pointed out, "In terms of other areas having to do with noise affecting the agency, it is interesting to see the association of noise with NextGen in ways that are not entirely helpful. We've been successful in leveraging other peoples' work like the Women's Health Initiative, and Medicare databases, and making inroads with the National Institutes of Health. We're getting wonderful collaboration with NASA Glenn and facilities there to collect data on particulate matter measurements since the need is so great to develop a database for standard setting."

02:50 pm – REDAC Committee Closure
Dr. John Hansman (REDAC Chair; Professor of Aeronautics and Astronautics, Massachusetts Institute of Technology)

Dr. Hansman mentioned, "When I asked Administrator Huerta where REDAC could be helpful, he said identifying the key UAS research issues. **(Action Item)** So this will still be tasking to the Subcommittees to get more specific and get a coherent representation for what the strategy is. **(Action Item)** The other place he mentioned that would be useful is looking for opportunities to do big data analyses. Take back to the Subcommittees the question of where is it that big data analysis could be useful?"

John further added, "In drafting a letter to the Administrator, in terms of the morning discussion, I won't get into too much detail about UAS, but will reflect that we've had the discussions and our finding is that there's a real need to communicate strategies and assumptions on UAS to the outside community and at a more granular level than before. Although it appears that many of these documents (examples: ConOps ,Derivation of Requirements, and Concept Maturation Plan) are held up in Executive Review, it would be beneficial to give the community a "conceptual draft or straw man" form that would help unify the committee around a set of research objectives.

The other item is to mention supporting Shelley Yah on the development of a high-level research strategy plan across research areas. Lastly, we would highlight the ICAO success on CO2 Emissions Standard and USA global leadership should be emulated by the FAA on UAS."

03:00 PM - *Adjournment*

Research, Engineering and Development Advisory Committee
Federal Aviation Administration (FAA)
FAA Headquarters, 800 Independence Avenue, SW
Washington, DC – 10th Floor Round Room
May 26, 2016

Agenda

9:00 am	Welcome Address and Opening Remarks	John Hansman Shelley Yak
9:15 am	FAA Administrator's Address	Michael Huerta
9:30 am	FAA UAS Overview and Perspectives	Marke Gibson Bill Crozier
10:15 am	Chairman's Overview – UAS Findings & Recommendations	John Hansman
10: 45am	Break	
11:00 am	UAS Discussions	REDAC Chairs FAA Executives
11: 45am	NASA Report – NASA Aeronautics FY 2017 Budget Request	Jaiwon Shin
12:15 pm	Lunch	
1:00 pm	Subcommittee Report – Aircraft Safety	Ken Hylander
1:30 pm	Subcommittee Report – Human Factors	Jack Blackhurst
2:00 pm	Subcommittee Report – Environment and Energy	Mahendra Joshi
2:30 pm	Break	
2:45 pm	Subcommittee Report – NAS Operations	Steven Bussolari
3; 15pm	Subcommittee Report – Airports	Christopher Oswald
3:45 pm	Committee Closing Discussion - Recommendations, Future Actions	John Hansman
4:00 pm	Adjourn	

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