



## NASA Advisory Council (NAC) Aeronautics Committee

March 27-28, 2014  
NASA Headquarters, Washington, D.C.

### Summary of Meeting Minutes

**Participants:**

<b>First</b>	<b>Last</b>	<b>Organization</b>	<b>Role</b>
Marion	Blakey	AIA	Chair
John	Borghese	Rockwell Collins	Vice Chair
Michael	Bragg	University of Washington	Member
Mike	Francis	United Tech Research Corp	Member
Tommie	Wood	Bell Helicopter	Member
Mark	Anderson	Boeing	Member
John-Paul	Clarke	Georgia Tech	Member
John	Langford	Aurora Flight Sciences	Member
Mark	Anderson	Boeing	Member
Karen	Thole	Penn State	Member
Lester	Lyles	National Research Council	Ex-Officio Member
Jaiwon	Shin	NASA/ARMD	NASA AA
Tom	Irvine	NASA/ARMD	NASA Deputy AA
Susan	Minor	NASA/ARMD	Exec. Secretary
Ed	Waggoner	NASA/ARMD	Observer
Doug	Rohn	NASA/ARMD	Presenter
Charlie	Bolden	NASA/ARMD	NASA Administrator
Jay	Dryer	NASA/ARMD	Presenter
Robert	Pearce	NASA/ARMD	Presenter
Jon	Montgomery	NASA/ARMD	Observer
Starr	Ginn	NASA/DFRC	Observer
Tom	Tsoutis	NASA/OCFO	Observer
Mike	Mastaler	NASA/ARMD	Observer
James	Schultz	NASA/ARMD	Recorder
Cathy	Bahm	NASA/ARMD	Observer
Brenda	Mulac	NASA/ARMD	Observer
Rob	Anderson	NASA/OCE	Observer
John	Orme	NASA/ARMD	Observer
John	Cavolowsky	NASA/ARMD	Observer
Dan	Hendricksen	AIA	Observer

Ed	Goldstein	AIA	Observer
Alan	Angleman	NRC/ASEB	Observer
*Gabriella	Ra'anan	U.S. Congress Staffer	Observer

\* participated remotely

### **Morning Session, Thursday, March 27, 2014**

The meeting was called to order at 9:13 a.m.

### **Introductions**

Ms. Marion Blakey opened the meeting and welcomed members and participants, including Gen. Lester Lyles. A discussion ensued about the upcoming results of a Gen. Lyles-led National Research Council review and report publication on autonomy in civil aviation. Ms. Blakey said the report will have a lot of public interest. Ms. Blakey asked for introduction of attendees, and then asked to discuss the Aeronautics Committee's work plan going forward. There were nine findings in 2013 and one recommendation. Ms. Blakey asked for continued discussion about the Committee's Unmanned Aircraft Systems (UAS) recommendation.

Dr. Jaiwon Shin said that the Committee's recommendation provided opportunity for the UAS in the National Airspace System (NAS) Project to consider and reexamine what was going to be done before the recommendation was made. In Dr. Shin's opinion, there was a fruitful exchange: a win-win situation, with challenges and valuable input from the Committee that really helped.

Dr. Edgar Waggoner, director of the Integrated Systems Research Program, said there was an integrated human-in-the-loop (HITL) simulation. He said that, although the Committee's suggestion was a sort of capstone flight associated with the activity, the Program thought that flight into Los Angeles International Airport was "a bridge too far." The UAS in the NAS Project's Phase 2 objectives provide validation of data regarding communications and sense and avoid, as well as validation of the Federal Aviation Administration's (FAA) Automatic Collision Avoidance System (ACAS-X) and its UAS variant, ACAS-Xu. Tests are planned with the FAA and General Atomics. Capstone flights are slated for early 2016, for sense and avoid, as well as communications, and assessments of the interplay of standards with ground stations. Two flights, in Class A and Class E airspace, will likely occur, and one possibly in Class G airspace. Class E airspace would be the main point of transit into Class A to see if performance standards actually work.

In response to a question from Dr. Mike Francis about the portability of aircraft types, Dr. Waggoner said the Program would be flying larger aircraft. There are the HITL simulations and the two test flights. The location of the test flights has yet to be decided. Meetings have been set up with six different [potential] test sites. In response to a question from Mr. John Borghese about cooperative versus non-cooperative aircraft, Dr. Waggoner responded that the non-cooperative aircraft will be virtual, whereas the cooperative aircraft will be virtual and live.

### **2014 Draft of NAC Aeronautics Committee Work Plan**

A review of the ARMD reorganization was presented, including a pending focus on advanced composites. The outcomes of the autonomy study will likely be ready in time for the Committee's July 2014 meeting.

The ARMD Strategic Implementation Plan was discussed. The Aeronautics Research Mission Directorate's (ARMD) Fundamental Aeronautics Program is looking at industry needs. Mention was made of the transition to low-carbon propulsion, and real-time system wide safety assurance.

Ms. Blakey said the Committee will consider the draft of the 2014 work plan [for the Aeronautics Committee]. Upcoming meetings will be in July and December, with the venues to be determined. Mr. Mark Anderson commented that it was very useful to see this laid out before the Committee. Ms. Blakey added that the last Aeronautics Committee meeting of the current 2014 calendar year will be at NASA Ames Research Center, perhaps during the first two weeks of December. The National Research Council – specifically, the Aeronautics and Space Engineering Board (ASEB) – has asked Ms. Blakey to speak with them about how the Committee is approaching its recommendations. Gen. Lyles mentioned that Mr. Ed Bolton will be attending to give the FAA perspective. Ms. Blakey responded approvingly, noting that the ASEB has said it wants a closer relationship with the FAA.

### **NASA ARMD Fiscal Year 2015 Budget by Dr. Jaiwon Shin**

Dr. Shin said that ARMD has been working to prepare a sensible start to fiscal year (FY) 2015 with its budget implementation. The FY15 budget was the first opportunity to present to the U.S. Office of Management and Budget (OMB) the new ARMD organization, which NASA Administrator Charles Bolden approved in the summer of 2013.

Dr. Shin said that, going forward, the ARMD 2014 budget is \$566 million. A \$15 million reduction is coming from two areas. The first is a refocusing of rotorcraft research, which entails an \$8 million decrease. Because the U.S. rotorcraft industry is lagging behind the Europeans, Fundamental Aeronautics Program (FAP) director Mr. Jay Dryer and his team have been working to develop a technology development and research plan that focuses on civilian applications. In the previous portfolio, ARMD had too much emphasis on large civilian tiltrotors. Now, with the autonomous-systems emphasis coming into ARMD's portfolio, the runway-independent philosophy needs to be looked at. Mr. Dryer elaborated that has been helpful in the near term. Even considering the reduction FAP has made progress in explaining progress on the civil side, and is moving toward "vertical lift" nomenclature to open up the tradespace.

Dr. Shin said that the second reduction, a \$7-\$8 million decrease, is due to re-prioritization across the agency, to which ARMD contributes. Dr. Shin said he was very pleased that Congress gave ARMD the full request in FY14 of \$566 million: a very positive sign. ARMD has gotten tremendous support from both the House and the Senate. All of the out-year budgets are notional but now include adjustments for inflation.

A discussion ensued regarding upcoming meetings, including one with the Joint Planning and Development Office (JPDO). The Federal Aviation Administration (FAA) recognizes and supports NASA's role [in the Next Generation Air Transportation

System, or NextGen]. Dr. Shin believes in a strengthening of the partnership between NASA and the FAA. While there is no JPDO budget this fiscal year, its functions will be absorbed into the FAA, and its administrative functions revised. The NextGen Institute will be maintained by the FAA, with details to be determined. The bottom line is that [senior FAA officials] will carry on the essential JPDO functions.

Dr. John Langford observed that while the FAA may absorb JPDO functions, the JPDO emphasis was on the future airspace, versus the FAA's normal day-to-day activities. JPDO was the right customer for NASA's work, since they were the most forward-looking and were really thinking about the future. Other parts of the FAA were not. At first blush that would be a serious loss because they were very good partners [for NASA]. Dr. Shin said that was a good point. He understood Dr. Langford's perspective and shares his concerns. ARMD will tell the FAA what ARMD thinks they should carry on, and will continue to advocate that, not just for NASA's interests, but for the community at large. ARMD will continue to push that agenda until the Department of Defense (DoD) is on board. The goal is to honor interagency cooperation.

Mr. Borghese hoped that the ARMD vision could help drive the future. Dr. Shin's reply was that "We are going to try to fill that role; we will never give up that role." He expressed the belief that, "in the years of working together, the FAA has come a long way." Ms. Blakey said that the FAA would say NASA has come a long way as well. From the vantage point of the private sector, it is a good thing that [the FAA is] keeping the NextGen Institute. Gen. Hoot Gibson, the director, has long-established relationships with the community. There are a number of projects underway; it is a fertile area for all potential and current partners to consider together. Ms. Blakey advised that no one should overlook the Institute's potential contributions, because it would be a mistake to do so.

Gen. Lyles cited ways to involve the National Research Council. In response to a question from Mr. Borghese about discussion of unmanned aerial systems (UAS) in the national airspace system (NAS), Dr. Shin said that Gen. Gibson had high praise for the UAS roadmap; he thinks it's an important area.

Dr. Shin concluded his presentation by noting that the Environmentally Responsible Aviation Project will be ending at the end of 2015. He cited the ARMD reduction of its programs from six to four, and mentioned the ARMD Aeronautics Vision for the 21st Century, which includes investments abroad in aviation research. Dr. Shin said the Vision has been very well-received by Congress.

### **ARMD Program Reorganization by Mr. Thomas Irvine**

Mr. Thomas Irvine discussed ARMD's six strategic thrusts. They have been fashioned to be responsive to mega-trends, as well as availability and use of energy. ARMD is aware of technology convergence, and is organizing to address all of these issues. ARMD continues to look at ways to better integrate and combine new technologies in the 21<sup>st</sup> century air transportation system, especially in terms of vehicles.

ARMD has an institutional responsibility not only internally but to the nation at large. Because ARMD is really a mission directorate, it has created new mission programs. The new programs will retain the scope of the existing programs, but expand on them and thus will be better able to transfer information. To answer the question of what are

the big problems aviation needs to be working, and how does NASA provide the leadership to get there, ARMD is looking at capabilities and responsibilities. There is a question of workforce as well. Mr. Irvine cited NASA's aeronautics test facilities, and changing the mentality from institutional sustainment to strategic capabilities, which will enable greater agility and flexibility.

The structure of the ARMD Integrated Systems Research Program (ISRP) was borne out of discussions within Aeronautics Committee. ARMD doesn't want to lose the ISRP scope and flavor, but wants to give it a more flight research focus. At the end of the day, vehicles have to be flown: that is a way to radically transform aviation.

In response to a question from Mr. Borghese about the idea of flexibility regarding aeronautics test facilities, Mr. Irvine said there were concerns about a compartmentalized workforce. The Aeronautics Test Program was spending a lot of time and energy balancing the books by the end of the year. The idea now is to take those resources and integrate them at the program, project and engineering level. What does ARMD really need in terms of these capabilities? What ARMD is trying to do is get the balance right between the resources that are being invested in numerical simulations, ground facilities and flight assets.

Mr. Borghese cited an engaged workforce as a positive; however, reports indicate that only 27% of the national workforce is fully engaged. Dr. Shin said that ARMD doesn't have that measure today, and that is why they're laying the groundwork, to provide an environment to scrutinize up front. Dr. John-Paul Clarke asked if ARMD was thinking about the Defense Advanced Research Projects Agency (DARPA) model, where industry comes and says, this is the thing we should be working on, and give us the best you can in two years. Dr. Shin said it was not a complete carbon-copy model, but there were certainly similarities: "We are trying to create some of the Google culture, some of the DARPA culture. I think our workforce has it, but in the last 10 years, people have been asked for the charge code first [before the work begins]."

Dr. Clarke: "How do you decide what gets funded? Will there be a portfolio approach?" Dr. Shin said the details will come up as the briefings to the Committee progressed. with the briefings. Dr. Mike Frances said the DARPA model works because the agency has the ability to hire the best individual for the work to be done. He asked Dr. Shin what ARMD was doing to provide the right skill sets for the future. In response, Dr. Shin said that ARMD certainly understood that, and is seeking the help of NASA centers management. He didn't know if the effort would succeed; if not, "we'll become dinosaurs."

Mr. Anderson said he thought there would be a lot of potential with the seedling program. A discussion then ensued regarding the mix between internal and external collaborators in the seedling program. It could be an exciting thing for the workforce, and great for universities also. In addition, an X-planes-like approach is beneficial. NASA isn't just research and development, but the nation's banker for aviation research. The workforce has to be there for more than four years, which is different from the DARPA model.

Addressing the formation of the new ARMD Airspace Operations and Safety Program, Dr. Clarke expressed concern that aviation safety will be worked only from the component level. Mr. Irvine replied that that integrated complex systems will be

considered from the start, and will involve much more than tweaks on safety. Mr. Anderson said that he was thinking about how the strategic thrusts will map; taken one piece at a time, it will make sense.

A discussion then followed about transitioning from one thrust to another, across a variety of the four new programs. ARMD hasn't thought of that in quite those terms. Mr. Irvine cited the ERA Project: ultra-efficient flight covers the waterfront in terms of what ARMD does. Research is conducted where the work logically needs to occur, perhaps in multiple programs simultaneously, sometimes sequentially.

Dr. Shin said the Committee has been briefed about the ARMD technology challenges, which are coming together. It is a mosaic, and ARMD wants to make sure they're working on the right challenges: "We're not in perfect phase, but we're moving in the right direction .... So far the construct we have seems to be the best approach."

In response to a question from Mr. Borghese about the nature of the feedback ARMD has generally received internally regarding its restructuring, Dr. Shin said that, anecdotally, it ranges from positive to very positive. Mr. Irvine said that the general attitude has been, how can I help? Gen. Lyles then asked about stakeholder expectations in Congress. Dr. Shin replied that, so far, he has only spoken to congressional staffers. One group really cares about aeronautics; they enthusiastically support what ARMD is doing. The other group cheers aeronautics, but their attitude is "do no harm" to their individual area of interest, specifically space.

A discussion then ensued about the value NASA brings to the country, in terms of aeronautics research and development. Dr. Shin said there needs to be cost sharing as well, which ARMD has been building up with industry over a number of years. ARMD now wants to explore that with universities. Mr. Anderson then cautioned that universities are also strapped for cash.

In terms of the Advanced Air Vehicles Program, ARMD wants to do an overland supersonic flight demonstrator, but is not looking at a suborbital flight from any aspect. NASA's ambition is to do work, culminating in a flight demonstration that will provide data to the FAA so they can make a responsible decision if they permit supersonic flight overland. A discussion then followed about the interaction between NASA and the FAA regarding overland supersonic flight. Acceptability research about boom shaping continues, but there is not yet an agreed-to standard.

Dr. Clarke observed that ARMD needs a community – or person – of courage to say this is what the regulation will be, and then asked if that community of courage exists. Mr. Dryer responded that it would be hard to say a person of courage, although there is a group of people moving toward that. Dr. Bragg wondered what would prompt the FAA to make a change like that. Mr. Irvine responded that there has to be a business imperative. ARMD believes that there is interest.

According to Dr. Shin, there are a lot of skeptics and doubters asking questions, which is a good thing. ARMD has been thinking it through. When considering the international scene, if NASA slows down [its supersonic research], some other country will step in. Dr. Shin: "It's a leadership role. Are we ready to do it or not? We think we've identified a proper government role. We're going to propose a research plan about what we think what should be done. But stakeholders and the country may not want it to be done." Dr. Shin cited

China, a vast country that has no problems about moving millions from one city to another city. The Chinese may build a [civilian supersonic airplane] and fly it over their territory. Then it will be rather like the Space Race, and the United States will be running to catch up.

Mr. Anderson agreed, saying that Dr. Shin had it exactly figured out. It's all just what-if until somebody demonstrates it can be done. This activity would be an entirely appropriate thing for NASA to do.

Dr. Langford said he would interject a note of caution. Considering the Concorde, international competition doesn't always stimulate the United States to do anything if it isn't economical. Sonic boom is very different from the UAS privacy issue. In terms of NASA research, this has to be something that has a dual use: military justification as well as civilian use. Any program has to be carefully balanced. Mr. Borghese said he agreed 100% with Dr. Langford. The only way to do such work is to tie it to a military vehicle.

Dr. Shin said he appreciated all the comments. ARMD is not spending a lot of funds on supersonic-related research: "My personal view is, if nothing happens with the low-boom research, then hold it ... If there's no market, let's not spend money."

In discussing the Integrated Aviation Systems Program (IASP), Mr. Irvine emphasized that ARMD doesn't want to lose the work already underway by its predecessor, the ISRP. ARMD does want to help create flight demonstrators. In response to a question from Mr. Anderson about just capturing advances at low technology readiness levels (TRL), Mr. Irvine responded that if a promising technology were to graduate out of one of the mission programs, it would come to the new IASP. Other things would be born out of community need, and ARMD wants to be open to both.

Dr. Francis asserted that what's missing, and is a critical issue, is the integration of the not-capable human with the intelligent machine. He asked how those two forms of intelligence integrate. Mr. Irvine answered that, to ARMD, the human-automation interface is vitally important. ARMD hasn't lost sight of it. As ARMD figures out how to integrate, there wouldn't be anything that would be excluded from the IASP research.

Mr. Irvine concluded the morning session by noting the formation of the Transformative Aeronautics Concepts Program (TAC). Its creation comes about because the field of aviation is changing drastically, and "the aperture is wide open in terms of what research might interest companies out there."

### **Afternoon Session, Thursday, March 27, 2014**

#### **Transformative Aeronautics Concepts Program by Douglas Rohn**

Mr. Douglas Rohn discussed the ARMD reorganization and specifically mentioned TAC. In response to a question by Mr. Tommie Wood about how TAC would address the law of scaling, Mr. Rohn said it would be built in to individual activities. Dr. Shin added that, from ARMD's perspective, small scale has two perspectives – both size and dollars. At NASA Langley Research Center, there's a very small team working on the electric airplane concept. In 18 months, they did all the research, all the testing, built a testbed: proof of doing things differently.

Mr. Wood noted the engineering difficulties of scaling up from small to large. Mr. Rohn said that each activity is a competition of ideas. Part is exactly that: the sizing. Any proposal will have to account for that and must be real-world. The TAC team will have to show how it will graduate. Once feasibility is determined it could move to another program or [elsewhere].

A discussion then followed about developmental activities, flight testing, and changing the thrust area.

In elaborating on the TAC structure, Mr. Rohn described project attributes: short duration, meaning 18 months to three years. A discussion then ensued about seedling proposals, funding, and publication results. Dr. Francis observed that seedlings take more management, but they go to the core of the issue. A discussion then followed about annual budgets and setting up financing for seedling programs.

In discussing TAC's Convergent Aeronautics Solutions (CAS) Project, Mr. Rohn said it would focus on big challenges, conceive new multi-disciplinary solutions, and fund rapid feasibility studies. There would be regular reviews with the aviation community, and then a decision about what efforts to either transfer or terminate. In response, Dr. Francis said he was surprised ARMD picked only two to three years. Some efforts could take weeks, others a much longer time. Mr. Rohn said that was true; if the feasibility was there, the other programs may pick up such initiatives. Dr. Shin said that ARMD works on so many long-term things that they wanted to make a contrast [with the formation of CAS].

Mr. Anderson said he thought there were some really innovative things there. As ARMD considers its future, he suggested looking at crowdsourcing and crowd funding and a YouTube video. Today, if one writes a paper, "you're disqualified ... It's a whole psychological and sociological phenomenon." Dr. Shin said that is what ARMD is looking at. Nothing has been set in concrete.

NASA Administrator Charles Bolden dropped by the Committee meeting, and Ms. Blakey welcomed him on behalf of everyone present. Mr. Bolden elaborated on his understanding of the political forces active in the U.S. House and Senate. He said that, although there is a push toward civility, the various committees [that oversee NASA] are significantly divided philosophically. During Mr. Bolden's recent appearance, the subject of aeronautics did not come up. On the Republican side, there was a lot of focus on the Ukrainian crisis. NASA is in daily contact with [the Russian Federal Space Agency] Roscosmos. [Planning for NASA's proposed] asteroid redirect mission has been a challenge; Congress needs details, but NASA is not there yet. Mr. Bolden said that NASA is very aware of the 21<sup>st</sup> century challenges confronting the agency. He said the Committee should be critical and demanding. NASA relies on the Committee's feedback.

A discussion followed regarding how CAS would approach its mission. Mr. Anderson said CAS would have to be flexible in its approach. That's its value. Dr. Langford said that, in science, at the back of everybody's mind is whether one could win the Noble Prize. For aeronautics, it's the Collier Trophy. That's the kind of thinking that can help screen [the CAS portfolio].



In discussion of the Revolutionary Tools and Methods Project, Mr. Borghese asked whether ARMD has developed tools that are now industry standards, used by people. Mr. Rohn said, yes, there are several. Mr. Dryer said his presentation would be about the foundational research for these. Mr. Anderson cited the NASA Structure Analysis system (NASTRAN), and said the really big challenge today is complexity, which is probably related to software.

Mr. Borghese initiated a discussion about rapid response, and the constraints NASA now operates under that limit its organizational response times. He suggested employee surveys as a means of soliciting ideas on how NASA can become more responsive. Dr. Clarke cited the reporting requirements that prevent people from just going out and doing something. He mentioned [area rule discoverer] Richard Whitcomb; with all the current NASA constraints, Whitcomb would not have been able to achieve what he did. Creating a Whitcomb-friendly environment should be the goal. Dr. Francis said he would look for ways to have several off-ramps at the end.

A discussion then ensued about the difficulty of changing research directions. Mr. Anderson: "This is a really cool assignment, but I would encourage you and your bosses to open up the windows and ventilate." He cited examples of startups and how to shelter people who are truly innovators. There is a necessity for outside thinking. Avoid the entrenched, stifling culture. Dr. Langford said one must capture what is actually done. Public research and development is appropriate when the benefits are widely applicable to many people. Return on investment also means who can capture the benefits. Dr. Bragg cited the IT industry as attracting the best and brightest; that approach could do the same thing for the aeronautics industry.

In a discussion concerning CAS management processes, Dr. Clarke wondered that if the NASA centers nurture, couldn't they also compete against each other? It would be the old stovepipes. Mr. Rohn admitted that would be a risk, but the desired behaviors could also be rewarded.

A discussion then ensued about the venture capital process. There are many challenges and obstacles. There is the "waiting for the aero AA to leave" mindset. There should be dramatic in-person gestures from leadership. From the ARMD perspective, NASA centers management seem to be showing genuine support. The centers need to see the benefit. Dr. Clarke said that there's a fiat and there's an incentive. When people see other people working with others across centers and externally, and they get the resources and the recognition, that's an incentive.

### **Fundamental Aeronautics Program (FAP) Foundational Technologies Overview** **by Jay Dryer**

Dr. Clarke asked Mr. Anderson if the "NASA DNA" [in all aircraft] meme is being acknowledged at Boeing. Mr. Anderson replied that the timescales are so long that the NASA connection is forgotten. Wingtips, for example, go back 30 years. Overflow code for the space shuttle stack was developed at NASA Ames Research Center, but maybe 2% of Boeing executives know that. That's the reality.

A discussion then ensued about passive-aggressive behavior in industry. Concern was expressed over World Trade Organization (WTO) issues. On balance, there's a much

healthier relationship now. Mr. Borghese asked how the areas that are the most important can be identified. Mr. Dryer said there was no single answer.

After Mr. Anderson lauded NASA research on drag assessment of truss-braced wing aircraft, a discussion then followed about how more use of this could lead to much “greener” aircraft, but without the drag penalty. The separated-flow problem must be solved to make such an aircraft possible. It provides promise because of the system benefits. This is a narrow problem, but if solved, could open up whole new possibilities in aviation.

Mr. Dryer discussed the vision of computational fluid dynamics in 2030, and taking advantage of new computer architectures. Mr. Anderson observed that intuitive engineering doesn’t work when you try to solve problems you don’t fully understand. In presenting the FAP technical challenges and research themes mapped to strategic thrusts, Mr. Dryer said that “foundational” doesn’t mean just doing it for the sake of research. Dr. Clarke: “Here are the big challenges; here are the resources we need to address these challenges in order to progress aviation in the next 10 years.”

Mr. Borghese said that Mr. Dryer’s presentation all looked very good. But how did FAP decide on all these things, rather than one or just a few things? Mr. Dryer replied that part of that was because of inputs received both externally and internally. It was through a number of mechanisms, like the industry forums: an interaction which brings different groups together. The other thing that factored in is ARMD’s ability to financially support these activities.

Dr. Clarke: “Your return on technology investment may be zero, or may be huge. How do you guys deal with that when you have to make that decision?” Mr. Dryer replied that ARMD is doing it for the sense they have of where the future is going. Not every approach solves every problem. Dr. Clarke asked about whether evaluation plans were in place. Mr. Dryer replied that that was what ARMD is working on now: trying to come up with a method to show how ARMD is making progress.

### **Committee Deliberations**

A discussion ensued regarding unmanned aerial systems in the national airspace. Dr. Francis observed that there were three speeds [of adoption]: public, the FAA, and NASA is in the middle. Where does it go from here? It has the potential to do some things, even though there’s a lot of detail missing. [Government research] won’t go as fast as the public speed. Mr. Borghese said that the FAA has already lost control of the airspace. Dr. Langford said to create a new airspace and back propagate it. Ms. Blakey said that she didn’t think the FAA believes it has lost control.

A discussion then followed about NASA and FAA interactions. There is continuing engagement every step of the way. There is no control system below 1,000 feet today, and the national airspace is an amazingly anachronistic system. This is a way to invent something new. Apply Internet protocols, and it would be an opportunity to create a new airspace paradigm domestically. Don’t worry about what the FAA thinks: NASA can write on a clean sheet of paper. A new set of boundary conditions are being set and a new set of legal issues are arising. Dr. Clarke observed that some may explore the idea of buying airspace over private property. Dr. Langford said property owners could set up no-fly zones over the house, setting up hours low-flying craft would be prohibited from

encroachment. Mr. Borghese said that unmanned aerial systems traffic management (UTM) will flush out such decisions. Dr. Shin observed that it could be a very good testing ground for how to work with new technology, and how to share resources. ARMD has the opportunity to do a lot of non-conventional things, although roadblocks will likely include bureaucracy. Dr. Clarke: "I hear two things: This is an area you want to do work, but requires a nimbleness of organization that we don't have today." Dr. Shin: "I can cut some red tape myself, but there are functional offices in this building [that may impede these efforts]."

Mr. Borghese said that he may have overstated earlier, but he believes the FAA is losing control. What people are doing today is violating the law today, but they are not using the airports. Dr. Langford observed that what the judge said is they are not breaking the law, because there is no law. Everybody is going to love [the use of this airspace]. Ms. Blakey lauded Dr. Langford's optimism, but said there is a community out there that feels very threatened by this, and a substantial number are [in Congress]: "The last time I looked they controlled the resources. The black helicopter crowd will come out in force." Dr. Francis said there is a way to present the best options, not to propose one solution. That doesn't make it threatening; that makes it helpful. Mr. Anderson said that one could just go around and talk to people doing this: "We'd be happy to work with folks [domestically]. It seems to me it's inevitable it will happen." Dr. Langford said there will be two [airspace] rules: one for the small stuff, and one for the larger. The biggest danger is having your best people hired away by those moving faster than you are. It's a great sign you're doing the right thing, something important. Ms. Blakey said that she was hearing great endorsement for the UTM project. Are there specific endorsements? A discussion then ensued about cutting through the red tape, and being nimble across the entirety of NASA. Resources need to be allocated; it's an area fertile for public-private partnerships.

Mr. Borghese said that ARMD's transformative aeronautics program is right on; it's excellent. It's very hard to do and very hard to measure. Ms. Blakey said the discussion throughout about the reorganization makes a great deal of sense. It is very compelling. Mr. Wood said he agreed with the thrust, couldn't tell from the numbers how much money is available to execute the work. Of the \$79.5 million allocated to transformative aeronautics, how much is really being dedicated to the actual activity?

A discussion then took place about the budgeting numbers, and how the ground-test facilities are supported. Dr. Shin explained that the current Aeronautics Test Program (ATP) will be broken into two and will be integrated into two ARMD mission programs. That brings assets closer in to actual needs. What ARMD is doing today is what ARMD will be doing tomorrow. How to coordinate this to make some tangible progress by thrust will be the challenge.

Mr. Wood said he would like to see the rotorcraft work continue. Most of the [aerodynamic design] codes come from NASA, not the Army: "I don't see the Army stepping up to run that. I'd like to encourage you not to cut that too much."

Mr. Anderson said that, in terms of bringing back X-plane culture, the Defense Advanced Research Projects Agency (DARPA) been talking about that for two years. They want to go back to a more pristine approach, evaluating one or two technologies [per platform], at \$200 million every two years. There are a lot of people talking about that. NASA could advance that kind of goal in the right way. It's got to end in hardware

and in flight demonstrations. There's a whole lot of momentum and it needs to be kicked into gear.

In response to Dr. Langford's question about NASA's role in the [current] DARPA project, Mr. Dryer responded that ARMD has provided technical expertise, but is not directly involved. A discussion then followed about NASA getting too involved in military work. A tailless supersonic fighter will be in the offing; there will be opportunities to get involved in the supersonic side of that.

Dr. Shin asserted that the dual-use argument is a sure way to kill a program. Everything is being compartmentalized. The perspective is that the budget is tight, and everything you need you pay for yourself in your agency or department. NASA will not be allowed to team up with DARPA. ARMD is being told to stay with civilian applications.

A discussion then followed about rotorcraft underfunding. Mr. Anderson said that although budgets are very tight, it's truly unfortunate that NASA can't bring its assets and expertise to bear on national problems. Dr. Shin cited ways to work across NASA agency wide and with small companies as well. It takes much effort to build these new networks domestically and to collaborate internationally. Dr. Langford said it was painful to hear Dr. Shin say ARMD can collaborate with Canadians but not with DARPA. Dr. Shin said that ARMD was continuing to pursue all possible collaborations: "We can't do anything about the current environment, but we can't be paralyzed. We are going to work hard with industry partners to see what is possible. We're going to just keep pressing. And I haven't even mentioned a [technology] demonstrator. We can't just say we don't have enough money."

#### **Public Comments:**

None.

#### **Closing Comments:**

Dr. Shin said that ARMD continues to try to lay the groundwork for the future. All the things ARMD has talked about is because we're at the top of our game and we want to catapult even higher: "That's the message I've been delivering to Congress and to our NASA folks." Jon Montgomery observed that, in terms of the NACA 100th anniversary commemoration, ARMD is working on an agency-level campaign that will play out agency wide and elsewhere over the next 12 months. Dr. Shin lauded the ARMD leadership team, and Dr. Langford said that "there's incredible work you've been showing. It's really impressive." Ms. Blakey seconded that point of view.

**MEETING ADJOURNED** at 4:57 p.m

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## **Morning Session. Friday, March 28, 2014**

Mr. Borghese called the meeting to order at 9:06 a.m.

### **University Engagement by Jaiwon Shin**

Dr. Shin offered thanks to Dr. Karen Thole for her participation by phone today. He told the Committee that he was soliciting the Committee's ideas and suggestions. NASA Aeronautics has always worked well with universities, although the specific kind of relationship has changed from time to time. The basic motivation is to try to harness university capabilities and to support science, technology, engineering and mathematics (STEM) education. For the past six or seven years, ARMD has been primarily using the NASA Research Announcement (NRA) process, as well as cooperative agreements. Some years the ARMD investment has exceeded \$70 million, a significant percentage of the ARMD budget. Dr. Shin believes the university engagement has been very productive and fruitful for the ARMD investment.

Dr. Shin said he was not asking for the Committee's advice because something's broken or needs to be dramatically fixed. He wants ARMD to do even better. Exploring unconventional ways of collaborating is one approach, such as the technology center concept. Whatever improvements ARMD seeks won't make for a wholesale change. ARMD wants to ask universities to work with ARMD on big questions, not just individual principal investigator work.

Dr. Clarke said that all people are not good at all things: "Some of the things associated with reporting some of us are not good at. The NRA mechanism works best for me when I partner with a company. I would rather not do the administrative overhead." The money that gets in the hands of the students is less. Dr. Clarke said the main focus should be getting the money in the hands of the students so they can do the work. He cited the need for a mentorship system. The first strategy would be how to best enhance the fellowship program and make a commitment for three years at least. The second concerns the faculty and developing capabilities. A discussion needs to be created between faculty and students. ARMD needs to identify a set of faculty members and commit to work on a big item for a couple of years. Focus the team around the students the faculty needs. Create focus teams: the university, NASA and industry working together. The teams need to identify what the key issues are and tackle the key problems. The last piece is having a technical monitor on the NASA side who is really engaged.

Dr. Bragg said he agreed with most everything Dr. Clarke said. The focus should be on the student; NASA has an obligation to help educate people with Masters and Ph.D.s. For aerospace graduate students, the funding really comes from NASA, not the National Science Foundation (NSF). Larger center grants could be a possibility. Industry focus is also a plus. That's something ARMD might want to look at. [That kind of fellowship] is very cost-effective for NASA.

Dr. Thole said she couldn't agree more that it has to be about the student. A different model [citing her lab's affiliation with Pratt & Whitney] is an industry-affiliated center. In a center, one can develop a deep understanding about problems. Linkage with industry sponsors is very important. Penn State is a member with four other universities in an alliance [to support] the Department of Energy's National Energy Technology

Laboratory (NETL). That relationship has allowed Penn State to build a big turbine lab. It's a collaboration between the university, government and industry, and many of the projects are multi-year. It provides a long-term view on research, and "keeps the faculty hungry. You have to stay on game in terms of leading the research area." In the end, it's about the students.

Mr. Anderson cited the Air Force Research Laboratory (AFRL): AFRL chose universities within driving distance of Dayton, Ohio for collaboration with AFRL units concentrating on different areas of research. There is the triad: academia on point, supported by government, and industry involvement, as industry works on pre-competitive research.

In response to a question from Mr. Irvine about the motivation for situating efforts geographically for fairly easy travel, Dr. Thole said she couldn't say that there was a lot of trading back and forth. But these places are also looking to recruit students. A discussion then ensued about student recruitment. Boeing recruits from everywhere.

Dr. Francis said his company was involved in a similar consortium involving the NSF. The organization is multiple universities and eight companies, with allocations that can be changed annually. It's a similar model [to what's been discussed], and is especially helpful for information technology/software projects. The real issue is strategic and building relationships: What's the value proposition for each of the stakeholders? It can be made to work. This consortium is in its third or fourth year, and all the interested parties have done well.

Dr. Bragg observed that that model is not very student-focused. Dr. Francis replied that he wasn't suggested it should be pursued, but it is a model that [can be adapted]. Dr. Thole discussed work being shared among universities; an integrated program, with expertise called upon as needed. Mr. Anderson said he was describing something that allows Boeing to interact with AFRL and universities. It begins with research funds. Beyond that, Boeing will enforce proprietary rights.

Dr. Shin thanked the Committee for all their insights. ARMD will take a look at all suggestions. Student focus and triad development are the two mentioned in every example. There won't be dramatic change, but ARMD will explore. In response to a question about intellectual property from Jon Montgomery, Dr. Francis said that it was virtually a non-issue as long as one sticks to the science. Start developing specific software and it gets dicey.

Dr. Thole said that there are many different models that work out. If there's a piece the company is really interested in, they will work that on the side. Companies build infrastructure on the basis of the money that came from the grant. A discussion then ensued regarding intellectual property (IP): how it's developed, how universities reserve the right of first refusal, how companies benefit from access to new ideas, and the fact that universities need to own their own IP. Such property is effectively owned by the faculty member(s) doing the specific work, which makes ownership even more complicated. Making it restrictive discourages talented faculty from working on projects. Mr. Wood observed that leverage is shifting back to the companies because of the funding issue [i.e. funding reductions from state governments].

A discussion then followed about valuable information being generated through such projects. However, because of federal government restrictions relating to the

International Traffic in Arms Regulations (ITAR), that makes it very difficult for industry. There are obstacles and problems, depending on the field of study. Information technology makes autonomy practical. How to resolve that under ITAR is unclear. The fellowship path means the agreement is with the student, not the university. The environment is much more difficult for smaller companies. Student training is necessary to understand the ITAR details and its complications. Many firms can't hire international students because of these restrictions; that's what is preventing talent from coming to the U.S. from overseas. Non-green-card students have to be physically segregated from labs and assigned a separate computer system. There is a literal price to be paid from isolation from the global talent pool.

Dr. Shin's response: "It's everywhere. It's not just university relationships. We've been approached by foreign companies trying to get NASA talent. It's case by case, really. Every case is different. There is no phonebook or cookbook to go to."

Ms. Blakey reminded the Committee of previous discussions on exports. There is nothing that NASA could or should do in terms of taking a position. A short discussion then ensued about how technology companies stay out of trouble re ITAR. There is an overhead problem, and costs to customers and stakeholders.

### **System-Wide Safety Assurance Thrust Overview by Robert Pearce**

Mr. Robert Pearce outlined [airline-related] liability issues about sharing information, as well as competitive concerns. Going forward, the amount of information is going to grow. A brief discussion then followed about interrelated data tools, text mining and digital-data mining, and the detection and/or prediction of anomalies. Specifically, prediction is tricky and difficult.

Mr. Pearce said that NASA – although taking a broad perspective – will not take on every problem. Mr. Borghese suggested discussions with others engaged in similar efforts. Dr. Clarke made specific recommendations about what people to talk to, and noted, in terms of predicting behavior, the increasing practice by police of monitoring of Twitter feeds to predict potential gang activity.

A discussion occurred regarding data transmission and data transformation. It's a matter of not revealing the data in its entirety, but portions of the data. The timeline may be too heavily weighted toward the front end rather than the back end. Mr. Pearce said that ARMD is trying to identify the issues, and is listing the technical challenges: "If there is someone else solving it, we don't need to solve it; we just need to leverage it. I think we can take an approach while some of these really big challenges are being solved. We won't solve some of these challenges in five years [by ourselves]."

Mr. Borghese said that what ARMD is doing makes a lot of sense. But a lot of these are very hard to do. Where are the partners you need? Mr. Pearce replied that ARMD is working on a memorandum of understanding for cyber-physical systems research with the National Science Foundation, which is serving as a clearinghouse and making an investment in the basic research. ARMD will be looking to enter partnerships with industry. However, ARMD will not be doing cyber-physical security.

In discussing encrypted data, Mr. Borghese said "Right now it's unobtainium. In 30 years someone will solve the problem. Big data is what the commercial companies are looking

for.” Mr. Pearce answered in the affirmative when Ms. Blakey said that she assumed the discussion was about operational data: Anticipating a future where much higher levels of data will be swimming through the system. A discussion then followed on who is working cyber-physical security. Data that reveals a future event remains very difficult.

In response to a question from Mr. Anderson on how ARMD will attract the talent to work on this, Mr. Pearce replied that it’s the same issue with autonomy: ARMD is not sure. A brief discussion then occurred about attracting talent.

Mr. Borghese said that what ARMD is trying to do here is absolutely important. He urged focus on the prognostics part, as well as partnerships. A discussion then ensued about people and companies willing to work for and partner with NASA because they see it as a big benefit going forward. Google was cited as a partner already.

Mr. Irvine asked if there would be a clear NASA role where ARMD could make a contribution. Mr. Borghese replied that, yes, absolutely. Focus on your existing databases; because of the NASA cachet, some would be very interested in collaboration. Ms. Blakey observed that one could look at data from here to eternity, but there are real-world problems, like engine icing. Mr. Pearce replied that ARMD is already doing some of those things; if the effort succeeds, NASA may be able to identify problems that have yet to present. A number of real-world problems are being addressed through ARMD programs and projects.

Dr. Shin indicated that what he is hearing from the Committee is that if the need is there, someone has to work it, but NASA Aeronautics should not reinvent the wheel. There are all kinds of bigger players spending lots of money on things that are closely related to what ARMD is trying to do. ARMD shouldn’t waste its time and money [to duplicate efforts already underway]. ARMD will become much smarter about teaming up with partners. Mr. Borghese said that was very important in many different fields. The question is, can ARMD partner with companies already working on this to leverage their expertise? Mr. Pearce: “We are definitely learning how to do this.” Dr. Shin agreed, mentioning a data-mining expert who has left NASA to work for Verizon in the [San Francisco] Bay Area.

### **Committee Deliberations**

Ms. Blakey called for discussion about topics to be presented to the larger NASA Advisory Council (NAC). An Aeronautics and Science Engineering Board (ASEB) meeting is upcoming, so findings and recommendations should surface for the NAC. Mr. Borghese said that one is the reorganization and the attempt to change the ARMD culture. The other is Unmanned aerial systems Traffic Management (UTM).

Mr. Anderson said the Committee recognizes and supports ARMD program reorganization; and lauded both the transformative aeronautics and fundamental programs. But, he said, “don’t abandon the bedrock.”

Dr. Clarke said ARMD needs to be given the tools. He thought the Committee should say something about that. They should move with alacrity and cut the red tape. Mr. Wood said he wanted to push for rotorcraft research in fundamental aeronautics. There’s still a lot we don’t know.



Dr. Francis said he like the emphasis on vertical lift. The question is what's the long-term plan and vision and how it will integrate. Dr. Shin said that, with vertical lift combined with autonomous systems, there could be some exciting synergy. That is all part of the autonomy study ARMD is doing. Another part is electrical systems.

Mr. Anderson said that it was a sad day when NASA can collaborate with Canada and not with DARPA. It's truly unfortunate that NASA is not more involved with rotorcraft. And truly unfortunate that, on the verge of true progress in hypersonics, NASA is excluded.

Dr. Langford said that part of the job of an advisory committee is to raise uncomfortable truths: "You know you're doing good work when people are beating a path to your door. How is it that you can't get more involved in vertical lift? You've got to innovate to be invited to the party." Mr. Anderson said the restrictions are all about politics. Ms. Blakey said that if the subject isn't brought up, then concerns can't be aired. General Lyles then mentioned potential help from the NRC on behalf of these concerns.

Dr. Shin said that hypersonics research and NASA's role in it doesn't have to be tied to this [aeronautics] mission directorate. The current environment won't allow it. Rotorcraft is different, but not hypersonics. Mr. Anderson replied that he had doubts on whether other communities will give hypersonics due consideration. Dr. Shin then said the question is whether hypersonics needs to be in NASA's portfolio or not.

Dr. Langford said that the private sector is looking to recreate Alan Shepherd's flight. They're doing what NASA was doing in 1961. NASA is working on the space launch system (SLS), what NASA did in 1968. Somebody needs to be working on launch vehicles that are reusable but that haven't moved beyond the late 1980s. That's where hypersonics comes in. Dr. Shin said that was a very good way to put it. There wouldn't be any disagreement from NASA people.

A discussion then ensued about a next-generation vehicle, and how it's needed. Several programs were started, but ultimately weren't supported by the tech base. There is a need for a unified hypersonics approach, and NASA needs to be at the table as part of the team, and included in the dialog.

Ms. Blakey asked the Committee to turn its attention to UTM – unmanned traffic management, below 400 feet. The thought would be an approach that doesn't rely on [the FAA current practice]. What should NASA be doing more or different in this regard?

Dr. Francis said that it might be an interesting opportunity for NASA to engage in aeronautics in the same way it engaged other stakeholders in space in the 1960s. Mr. Borghese said the Committee might also want to consider how to break down barriers in all of NASA, and not just ARMD.

Dr. Shin said that a discussion can occur about speed and potential partners, but ARMD just can't have a handshake and start working. There's a lot of paperwork involved. Even government agency to government agency can take more than a year. A lot of opportunities have been lost. ARMD can do everything it can from the NASA end, but the process can take a very long time. Another issue is the procurement side. How can this be accomplished in a nimble way?

Mr. Borghese cited an effort with NASA Langley Research Center. It was cheaper to buy [existing technology] outright after seven to eight months of trying to negotiate a Space Act Agreement [with NASA]. A discussion then followed about procurements and delays. Memoranda of Agreement are laborious. Specifically, in terms of ARMD's Advanced Composites Project, large companies are involved, so delays are baked in. The chokepoints exist regardless of ARMD interest or expertise.

Dr. Francis suggested involvement of the NASA administrator to remove as many administrative roadblocks as possible. Ms. Blakey said it would be possible to reflect in the Committee's recommendation [the speed of private-sector transactions] and the need for nimbleness, as well as greater resources committed. To get this off the ground it will have to be fast. Dr. Francis said it could be framed as a matter of national competitiveness. Ms. Blakey said she was hoping to get out to the Aeronautics Committee the wording of two findings and one recommendation by next week.

Dr. Langford said he felt compelled to comment on the demise of the Joint Planning and Development Office (JPDO). The JPDO played a useful role. Rolling its functions back into the FAA doesn't solve the problems it was created to address. Dr. Langford added that he hoped NASA will look at this and reassess ARMD's role in assuming [some of JPDO's former functions]. Dr. Shin replied that that's what ARMD has been doing. Ms. Blakey said it was a very timely topic, and that she would be favorably inclined to put a finding together that addresses the issue. Gen. Lyles added that he hopes former JPDO roles can be more fully addressed going forward.

#### **Public Comments:**

None.

#### **Closing Comments:**

Dr. Clarke complimented Ms. Blakey on giving the Committee enough time to address all these topics. And Mr. Borghese said "And for keeping us on an even keel."

**MEETING ADJOURNED** at 12:02 p.m.

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