



NASA Advisory Council (NAC) Aeronautics Committee

March 23, 2016
NASA Headquarters, Washington, D.C.

Summary of Meeting Minutes

Participants:

First	Last	Organization	Role
Marion	Blakey	Rolls Royce North America	Chair
Dr. John-Paul	Clarke	Georgia Tech	Member
Dr. Michael	Francis	United Technologies RCenter	Member
Dr. Missy	Cummings	Duke University	Member
Dr. Lui	Sha	University of Illinois	Member
Tom	Wood	Bell Helicopter	Member
Dr. David	Vos	Google X	Member
Dr. Jaiwon	Shin	NASA ARMD	Deputy Administrator
Irma	Rodriquez	Aeronautics Committee	Exec. Secretary
Jay	Dryer	ARMD AAV Program	Director
Robert	Pearce	ARMD OAA	DAA / Strategy
Jon	Montgomery	ARMD OAA	DAA / Management

Wednesday, March 23, 2016

The meeting was called to order at 8:35 a.m.

Introductions

Dr. Jaiwon Shin welcomed new member David Vos from Google X to the Committee. Ms. Blakey reminded everyone that any potential ethical conflicts may require members to recuse themselves. Ms. Rodriquez welcomed committee members and welcomed members of the public. The minutes from last meeting were approved by acclamation.

ARMD 10-Year Investment Strategy by Dr. Jaiwon Shin

A brief discussion occurred regarding supersonics research in the aftermath of a recent public-private meeting. There is a need for industry and stakeholders to come together to pinpoint what's appropriate. Everyone is in it together. Dr. Shin noted that aviation is now part of the President's clean transportation plan that is government-wide. In reply to a question from Dr. John-Paul Clarke about how the plan fits in with the Smart Cities

Initiative, Dr. Shin said there's a connection, but if one reads the White House white paper, it doesn't directly link. Mr. Robert Pearce explained that smart cities is an ongoing initiative, and that the National Science Foundation may have invested some monies as well.

The Smart Cities Initiative will invest more than \$160 million in federal research and leverage more than 25 new technology collaborations to help local communities tackle key challenges such as reducing traffic congestion, fighting crime, fostering economic growth, managing the effects of a changing climate, and improving the delivery of city services.

Dr. Shin said that what he has reported to several Congressional committees will give the Aeronautics Committee some context. Eight years ago, when Dr. Shin assumed the post of Associate Administrator for Aeronautics, the Office of Management and Budget had allocated \$450 million for the NASA Aeronautics budget. Now, \$571 million is the request from the President for fiscal year (FY) 2016. Congress did add money during the lean years. Now, the value of NASA's Aeronautics Research Mission Directorate (ARMD) work has increased. The final FY15 allocation was \$650 million, and the FY16 enacted amount was \$640 million. The disagreement between the White House and Congress over the value of NASA's aeronautics research has been narrowed.

In terms of recognition and value, the budget is one measure. Eight years ago, NASA Aeronautics had lost all support from industry and the Federal Aviation Administration (FAA). Then, ARMD was only concentrating on fundamental research; today, the FAA is ARMD's strongest government partner, and the working relationship has improved dramatically. ARMD is not just doing sandbox research. Government-wide partnerships, notably with the Department of Defense, are all doing quite well. The Aeronautics Committee has shaped this progress with ARMD. In-kind industry contributions now stand at \$240 million, and technologies that have been transferred have been highly praised. The aeronautics community has been quite complimentary.

ARMD continues to take on new challenges identified by the Committee, like unmanned aerial systems (UAS) in the national airspace (NAS). Such efforts involve new money; no money has been siphoned from existing work. This Committee has been really supportive and has guided ARMD in the right direction. ARMD has garnered strong backing and increased budgets because of strong content. All the workforce has really delivered. Some critics have said that the \$3.7 billion [ARMD proposed 10-year budget] increase won't happen. But it doesn't matter whether it's discretionary or mandatory; if Congress sees it's valuable, they will find the money. If ARMD can convince Congress this is what the country needs, what the government needs to invest in, then the money will come. The real strength of the proposed budget is that it can be discussed very openly about what can be done if the country invests in NASA Aeronautics.

Dr. Clarke asked how much program acceleration would be possible and what it would cost. Acceleration of programs is possible, but workforce is an issue. Dr. Shin said it would be a big challenge, but the funding would have to be secured first. Dr. Clarke hoped Dr. Shin could make the case with the existing workforce and what can be achieved. He very much likes Dr. Shin's case for value.

Mr. Pearce said that ARMD has been working with industry partners to identify the most promising advanced aircraft concept configurations. Since ARMD has a pretty good

idea of where it wants to go, there's good confidence that the budget increase can be pushed through the pipe.

In response to a mention of examples of progress in developing ultra-efficient subsonic transport concepts, Dr. David Vos said that the world is beginning to recognize the enormous amount of greenhouse gases being put into the atmosphere. It's not sustainable. If one looks at the plot ARMD is presenting, it's maintaining current levels and is not addressing the issue. Cuts of 10% to 20% need to be made. Dr. Shin said that was very accurate. That's why ARMD has this plan.

Dr. Vos said that there is only one spaceship humanity is traveling on, and that's Earth: "So we better take care of that spaceship. There is a systems solution." Dr. Vos suggested a net carbon contribution to zero because the planet is in really dire straits. Dr. Shin said that was a global and necessary approach. In terms of aviation, the curve can be bent as biofuels are introduced and electric hybrid systems are developed. Dr. Vos said there needed to be leverage of the crowd source of the world to get there, as well as sustainable energy development. A system-level perspective would really position the work ARMD is doing here. Although there are real, measurable metrics that are being developed, there remains a missing systems-level perspective. Dr. Shin said Dr. Vos made an excellent point, and ARMD will work on it.

Dr. Michael Francis said that supersonic flight will require a systems-level perspective. He liked Dr. Vos' perspective: "We're not taking billions of people and going to Mars. If you're working strategic long-term, you have to work systems." Dr. Lui Sha mentioned different modes of transportation, like high-speed trains, and their environmental effects. Congress must move, because they make the regulations. If Congress doesn't move, then it's very hard for anyone, or anything, to move. There are many aspects, but aviation can do its part. The United States has very little and very poor public transportation. To reduce the carbon footprint, systems like high-speed trains are necessary. The total savings in aviation won't be that much.

Dr. Vos said that would be punting the problem. Dr. Sha replied that one must understand what can and cannot be done. Aviation has to do its part, and Congress needs to be convinced. Dr. Vos said it would be the integral of all the components. Everyone has to do their bit. Appropriate measures must be taken. Dr. Sha: "Two words: In proportion." Dr. Vos asked how Dr. Sha understands the proportion. Dr. Sha replied that since the issue has been studied, it just has to be cited. Dr. Vos: "So cite it. Let's put it in context."

Committee Chair Ms. Marion Blakey said she wasn't sure what was being advocated. Is there a specific proposal? Dr. Vos answered that it was about how much fuel aviation can afford to consume. That sets the level. Everyone has to take responsibility. Society cannot continue at the same rates. Are the improved rates [of emissions ARMD is proposing] good enough? There are potentially great solutions.

Dr. Francis said that presently the problem is being attacked two ways. The would-be fix is piecemeal. Is there a leadership role to play here? The question is how to do this to get to a mutually agreeable target. This is an outreach problem that goes beyond aviation.

Mr. Pearce said that the aviation community has set goals: 50% reduction by 2050. ARMD has set its priorities to help achieve that very challenging goal. If a bigger role is required, this will have to get to the NASA Advisory Council as a whole. There's nothing that can be done with the analysis without the right emphasis.

Dr. Sha discussed the possibility of solar and biofuels. Dr. Vos said that what he's advocating is making use of the material that already exists. The first chart should be "this is our chunk" of the solution. Ms. Blakey said that the discussion should be put in larger context and taken up at a future meeting. A remarkable job has been done in setting this 50% standard [globally]. Dr. Clarke said that talking about targets is a first step. He personally would like to see how exactly to reach the target. What is the value of the investment? It's a relationship between investment and outcome. Mr. Pearce said that the number of variables are huge. Dr. Clarke wondered, again, about the value of the investment. Ms. Blakey said it was a big and tough topic that would be returned to at the end of the current Committee meeting.

Referring to NASA's plan for a series of experimental vehicles, or X-planes, Dr. Francis said because X-planes always have issues, he didn't think it prudent to work on more than one X-plane at a time. Dr. Shin said that if ARMD were to proceed with multiple flight demonstrators, even if all the funding were to be put in place, it would still be a daunting challenge to do them all. ARMD would want to do at least two: the hybrid wing demonstrator is one; it has the merit of collecting a number of technologies in one platform. ARMD would want to test one or two technologies on the other X planes, and will be aggressively seeking cost sharing.

A discussion about hybrid electric propulsion ensued, with points made about how to apply what already exists and is being invented in other areas. Dr. Francis said that it would be valuable to have a cadre of ARMD personnel familiar with what's going on in industry. Dr. Vos said that the interesting revolution is small unmanned aerial vehicles, or UAVs. Even in that context energy-density storage matters.

Dr. Francis noted that autonomy is much more than the aviation system. One should be careful in how it is parsed. How humans fit into the equation is a really big issue. Dr. Shin said that ARMD is actively debating how to implement autonomy research. Whether any of this research is realized or not, there is a baseline budget: "We will put our money where our mouth is," Dr. Shin said. "We've got to go through sanitizing and rationalizing our current portfolio. That's the direction we're going."

Dr. Clarke wondered about ARMD's involvement with the U.S Air Force (USAF). One issue the USAF is struggling with is replicating the real world in simulations: downloads, maintenance and malware. To have assured autonomy, there needs to be a way such challenges can be resolved, especially with a hybrid approach. He cited embedded UAS architecture that would ensure both security and safety assurance. Otherwise, an accident is waiting to happen. Dr. Shin agreed, noting that ARMD is working on strategies to assure that. He said that ARMD should be able to increase funds to unmanned aerial systems traffic management (UTM) research by about 30% above its current \$50 million level. Mr. Pearce said that an analysis is ongoing about the ARMD investment portfolio, and that it's part of the 2017 budget formulation. Dr. Shin said that there are so many moving parts concerning UTM that it is difficult to find the one thread moving through the story. The FAA does want to do what it can as fast as it can. Dr.

Francis said there is a bigger strategic picture. Dr. Shin said that NASA can play a positive role.

Dr. Vos said that what's happening in the small space is the harbinger of what's coming. One can build solutions that are scalable. There's a significant wakeup call here. Four hundred thousand UAVs were registered in the last month and millions may be sold this year. Dr. Sha said that there needed to be collaboration with the FAA to secure an on-board element. There needs to be a lighter-weight certification procedure, safe and secure. Dr. Shin said there was no disagreement with what everyone is saying. The reality that we live in in the community is that this is a very delicate situation. If NASA moves out too fast working with the community, the FAA will view that as putting the cart before the horse: "[They would say] it is our [the FAA's] domain, and we don't want your help. Otherwise, a man-made setback will happen."

Dr. Clarke said that, in terms of Next Generation Air Transportation System (NextGen) technologies, thinking about tying UTM with the ARMD test flight program would be a good story: it's synergistic. All those things fit together. Dr. Vos recommended taking a look at performance-based requirements. Allowing industry to bring forth solutions is enormously synergistic and powerful for the world; it really works. Dr. Vos replied in the affirmative when Ms. Blakey asked if his comment applied equally to UTM.

Dr. Francis cited the growth and maturation of the airplane. Human intelligence played its part. Now, how humans trusted this combined system is changing. Now software is playing a major role. Dr. Sha said he was very much in agreement.

Dr. Shin cited recent remarks by House Majority Leader Kevin McCarthy supportive of NASA Aeronautics, saying that ARMD's efforts are paying off: "We're not splashy, but Congress understands we're trying to do the right thing for the country. Even if we get a slight increase, we will be able to do some of this. Now the story is out and we are getting tremendous support. All the planets are so far aligning."

Ms. Blakey asked for an explanation of mandatory versus discretionary spending. Dr. Shin replied that NASA is part of the federal government's discretionary funding. Social Security, Medicare and Medicaid are mandatory. The subcommittees that deal with NASA in Congress only deal with discretionary funding. The president requested \$800 million of mandatory spending in research and development; ARMD's share of that is \$150 million. But because of two-year budget deal, the administration can't ask for a discretionary increase which is why it's on the mandatory side. It's convoluted, but there's a way. The question is what Congress will do. It is a big uncertainty, but Congress can move money around. Dr. Shin expressed his sincere thanks for the Committee's support. At the critical time, the Committee has supported ARMD and stepped up and helped NASA Aeronautics. The way the Committee has handled the new work ARMD has requested funding for has been really effective. Dr. Shin said: "I haven't worked harder or smarter than my predecessors; what has been different has been the stability over a sustained period of [eight] years. And bringing in new [Committee] members has worked very well. Again, thanks very much." Ms. Blakey congratulated Dr. Shin, and said progress was a reflection of his leadership.

Ms. Blakey reminded the Committee that all of its deliberations today would be reflected in a short synopsis she will present in the coming week to the NASA Advisory Council.

In response to a question from Dr. Vos about connection to emerging business, Mr. Pearce replied that ARMD would undertake challenge prizes to see if responders have the technologies to achieve the challenges or concepts ARMD has. ARMD recognizes that aviation is shifting. How does NASA Aeronautics balance its interest between, say, vertical lift and new vehicles?

Dr. Missy Cummings said that when a request for proposal went out from ARMD to the university community regarding the best UTM concepts one could develop, the professors she spoke with laughed. Even if they were able to pull together something of that nature, it would be brought to Dr. Vos at Google. To be taken seriously requires serious funding. Mr. Pearce said ARMD agreed, and the next time “serious dollars will be on the table.” Dr. Vos said there should be a dedicated staff effort to identify what’s on the technology horizon. Dr. Shin said that requires “waking up our own people. We’ve got to diversify our horizons.”

Dr. Vos said that, in ARMD slide presentations, there needs to be a bulleted item that says ARMD is always going to connect to the community. Such an effort must be funded and incentivized. It’s a portfolio element keeping a finger on the pulse of what’s emerging in the industry worldwide, and paying attention to what’s happening in the venture community. Dr. Francis said he agreed. Dr. Vos said he would recommend creating a group within ARMD of 50 people, 10 of whom would travel all over the world and return with “fantastic ideas [that are the] conduit to information about the future.”

Dr. Francis said that if a really new innovation came along – electric propulsion, energy efficiency of any kind – that opportunity would be non-linear. He hopes ARMD planning is tempered with that in mind. Mr. Pearce said he would discuss that later in the meeting. Dr. Francis asked if there was anything happening that would occur nearer-term. Mr. Pearce replied that what is contained in the budget is a plan for research acceleration. ARMD so far has delivered six or seven software tools to the FAA that it has put on its roadmap for deployment. ARMD may be ready technically and have the credibility, but the aviation community at large has to get on board as well.

Dr. Vos said it was time to declare that “we will get to the NextGen moon by 2020. If FAA and NASA team, then it will happen and it will be a wonderful transformation point for the world.” Dr. Clarke said he agreed, but cautioned that some things are not tailorable. Dr. Vos said it wouldn’t be fair to nitpick to define what’s NextGen. But ARMD “needs to be partners in crime with the FAA. It’s such an enabler. Make it happen. We don’t want to show an experiment, but an actual working system.”

A discussion followed about how and when to make NextGen a reality. ARMD is technically ready to take that leap. Doing a demo and getting it into the system is crucial. There’s always a way to say no, but the entire effort needs to be driven by the United States. Dr. Clarke observed that NASA knows how to achieve technologically and buy down risk at the same time. Dr. Vos said that partnership will make it happen. Ownership happens right away because everyone has bought in.

Ms. Blakey said that an interesting situation has developed. Industry is more critical, but has done a lot to throw sand in the works. It’s because of cost, but there are also doubts whether government can deliver. There has been talk of taking air traffic control out of government management. That’s a huge political challenge. But there’s a question of what it will take for industry to be a full partner. More than half the cost is on the industry

side. It's not a moon shot, because government, NASA, had full control of the actual moon shot.

A discussion ensued about taking a NextGen leadership role and strategic positioning. There has to be commitment to the goal. Vision may come first, but industry changes its mind all the time. Automatic Dependent Surveillance – Broadcast (ADS-B) technology has dropped in price from \$7,000 to tens of dollars. Industry has come up with terrific solutions, but infrastructure matters even more so than intent. Proactive collaboration is required. For progress to be made, there is need for a neutral leader who knows industry and can speak to both NASA and the FAA. There should be an initiative to put the pieces together. Yet, there is a lot of regulation in place that can slow progress. Technology acceleration is very non-linear and becoming more so: electronics, miniaturization and software are converging and should be recognized. Proof-of-concept demonstrations can be done in the space now occupied by vertical lift vehicles. There is a big difference between a passenger jet – the metaphorical equivalent of a slow-moving ocean liner – and the equivalent of a speedboat: UAS and UTM. Thought needs to be given how to use UAS and UTM to move NextGen implementation forward.

Mr. Tom Wood wondered about changing laws permitting overland supersonic flight. Mr. Pearce said that requires working closed with the FAA and the International Civil Aviation Organization (ICAO). Dr. Vos said there was the possibility that supersonic commercial flight is an exercise in futility. The business case is hard to make. But a potentially revolutionary development is getting to 200,000 feet and then gliding, which gets rid of the sonic boom. Mr. Jay Dryer pointed out that there is new and promising research, and future enabling tools, conceding that an additional technology jump would be needed.

Dr. Vos said there was a question about total cost of biofuels. Mr. Dryer said that NASA and the FAA have led in development of a national strategy. Lifecycle analyses are ongoing. There is a regional solutions path. Mr. Pearce said that some of the models getting the community to essentially carbon neutral by 2020 have already been done. The faster the transformative change on the vehicle level means no lock-in of vehicle type. There is a need for vehicles that can cruise at 50% fewer emissions and a need to accelerate that effort.

A discussion followed about having vehicle models available to sell to increase community interest. There should be range validation so industry feels comfortable going forward with a configuration. Dr. Shin said ARMD should push the technology as far as possible and then pass it on to industry. Dr. Cummings said there is technology that is more readily available today that can be transferred already or sooner. Dr. Vos asked if there would be a way to propose acceleration of decision making to get things moving faster, like an incentive for a competition involving innovators. Mr. Pearce said the vision is the 50% reduction to get the competition going. Mr. Jon Montgomery mentioned there is already some competitions involving several international organizations.

Mr. Pearce said that vertical lift (VL) is working to improve on noise, efficiency and safety, and asked how VL becomes more of a part of the system. Dr. Cummings noted pending advances in Chinese vertical lift vehicles. "NASA will be caught with its pants down by 2025 after that happens," she said. "Commercial development is happening very quickly, and is occurring in companies around the world." Mr. Wood said it was a

matter of safety and the involvement of the National Transportation Safety Board. Also, costs must be reduced for the technology to be applied. Mr. Pearce wondered, if millions of VL vehicles are airborne, and there's the acute need to eliminate crashes, what are the safety concerns? Dr. Cummings said there is a need to sit back and learn what the current landscape is and get the noise signature way down because it will have a big impact. Safety is a big concern. The companies are very immature and don't understand the best practices. The 2035 goal is too far out and needs to be reset to sooner. When is the technology ready? Is it 2035? Mr. Dryer replied that ARMD is working those goals now. There is a focus for both traditional systems and for the small versions.

Mr. Pearce said that, in the transition to low carbon, in the near term to get any range on an airplane there first has to be hybrid electric propulsion. Dr. Francis cited fuel cell technology that will drive down significantly fuel costs and it's worth adding to the mix. Mr. Pearce said that energy storage is first on the list in regards to prizes; nothing precludes any energy storage solutions. Dr. Sha said that hybrid systems must be adopted if one wants to push quickly down the carbon footprint. The migration part is very important. Leave the door open to other technologies, but hybrid is crucial. Dr. Francis said that the community should be demonstrating what is on hand now. Dr. Vos said to "fall in love with the problem, not the answer." Mr. Dryer said that ARMD wouldn't preclude anything. Dr. Vos said that "things that are written become biblical [even though] they may not be true."

Dr. Francis observed that one of the biggest issues critical in the near term is when machine learning is added to the system, plus human intelligence blended with machine intelligence. How do we learn to trust it? Mr. Pearce said that ARMD has "two swim lanes focused on those issues." Dr. Vos said there was too much concern over machine learning. There is much work to be done before non-deterministic autonomy should and could be deployed. Much nearer term is deterministic autonomy. In any case, there needs to be a comprehensive strategy. Dr. Sha pointed out that even though adaptive control has been around 25 years, the FAA has yet to certify. Adaptive control is non-linear; if it's going to be done, it should be done right. To date the only thing the FAA has been willing to certify is a linear system. Dr. Francis countered that humans are the ultimate adaptive control; the FAA certifies that every day. Dr. Sha said there should be a change to behavioral-basis certification. Dr. Vos said he would open the solution space to a challenge, but not provide a single answer. The problem needs to be stated. Those in the industry need to finish the job of building an automatic airplane. It's not a matter of pointing fingers. Finishing the job it will take everyone into the next century.

In terms of planning priorities, Dr. Shin said that ARMD needs to take a position. He fully understands that ARMD shouldn't proscribe solutions, but there is a difference between proposing a solution and establishing a direction. He said he really did appreciate the preceding discussion. All industry has been smarter using automation to make drivers better. ARMD wants to take this out to the community at large and solicit input. In the past – Dr. Shin emphasized that he wasn't being at all critical – ARMD set very lofty, very challenging goals without much substance at all. There was no follow-up with universities or customers, and the goals fizzled out in three or four years. ARMD will not do that again. The six thrust areas are designed to set challenging goals. ARMD isn't wedded to any of this, to any one chart. It will be a living document.

Dr. Clarke said that the autonomy report notes that the safety part is very expensive. How do you put the benchmark out there and yet come up with a solution? Dr. Sha said that Dr. Shin in facing Congress has done a fantastic job. With backing and money from Congress, there must be challenging goals and feasibility. Showing an example is not imposition of a solution. The Committee should have the same approach Dr. Shin has adopted in turning this whole thing around. It's okay to show one path and to have a performance-driven goal, and then say please come up with something better. Dr. Vos praised ARMD's iteration of its six strategic thrusts.

In response to the ARMD's presentation of NASA/U.S. Air Force Executive Research Committee (ERC) meetings, Dr. Sha asked about the Air Force's [proposed] SR-72 and hypersonics capabilities. Dr. Francis said the Air Force is interested in hypersonics because of weapons as well. Ms. Blakey said she thought there was a tremendous problem in the Department of Defense not picking up on hypersonics research as it should have. She said she was glad ARMD was picking up on it. Mr. Montgomery said ARMD thought so too. The ERC is for aeronautics for now. The plan is to meet every six months and focus on one major topic. ARMD can make the connections with the right NASA organizations if the Air Force wants to do the same thing for space.

Dr. Sha: "What's the value-added for NASA for hypersonics research?" Mr. Pearce: "We can piggyback [on Air Force vehicles] and get data to move hypersonics research forward." Dr. Cummings said that the Air Force aeronautics and space communities are much farther apart than those communities are within NASA. A discussion then followed about how to push hypersonics research forward. ARMD can leverage and is leveraging Defense Department approaches.

In response to an ARMD hypersonics research update presented by Mr. Dryer, Dr. Vos asked if the main reason for existence of the research was as a bridge between the military and the civil. Mr. Dryer replied that most of the benefits accrue right now to the Air Force. Ms. Blakey asked about the role of the Defense Advanced Research Projects Agency. Mr. Dryer said that it was the Air Force Office of Scientific Research that was involved. Dr. Vos wondered whether hypersonics research would be a fledgling activity at NASA or an activity that benefits the Air Force. Mr. Dryer said that ARMD asked that same question. NASA brings unique expertise to the table. ARMD is also involved in the National Partnership for Aeronautical Testing, a council co-chaired by NASA and the Department of Defense. The council's charter is to develop an integrated strategy for the management of national aeronautics test capabilities and to enable national cooperation and coordination.

Mr. Dryer said that ARMD's proposed Hypersonics Technology Project is the right way forward, and can make significant contributions to the field. Dr. Vos it would be a sad thing to see hypersonics facilities and capabilities die on the vine. Mr. Dryer said ARMD agrees and is why ARMD is heading toward project establishment. A lot of the work is informed by previous research.

Dr. Vos said it would be advisable to feed the pipeline with new blood and reach out to universities. Mr. Dryer said the issue had come up and ARMD is still looking at it. Dr. Vos advised bolstering the relationship with the Air Force even more closely in order to get access to the university students. Mr. Dryer said that ARMD is trying to do the best it can with the available funding. In the near term, focus on [research related to

hypersonic] is what ARMD can do: “We still have suffered with some of these start-stops.”

Ms. Blakey initiated a Committee discussion about the Committee’s nine-item 2016 Work Plan. One focus will be UTM flight tests, timing, focus and results: not just the flow of air traffic, but devising a system to enable it safely. It’s a question of system-wide support of UAS safety. The first two of the nine 2016 Plan items have been addressed today. UTM and UAS should be areas of focus, with hypersonics slated for later since the Hypersonics Project would start no earlier than fiscal year 2017. Dr. Francis said that hypersonics is a broad topic; if it moves toward application, then the Committee should be informed. Otherwise, it remains fundamental research.

In terms of the July 2016 meeting, Dr. Shin suggests only two topics: UAS/UTM and X-planes in context of New Aviation Horizons. Dr. Clarke said system-wide safety should be tied into UAS. Dr. Shin wondered if the third meeting should be the tone to address system-wide safety. Dr. Vos suggested it should be a blend of hard topics. Mr. Dryer said that more work needed to be done on advanced composites before that subject is addressed by the Committee. Ms. Blakey confirmed that UAS, UTM, autonomy and New Aviation Horizons will be the topics for the July Committee meeting at NASA Glenn Research Center. Unresolved is when a presentation will be delivered by ARMD on the status of high-altitude icing research.

Ms. Blakey said the Committee’s findings first go to Dr. Shin and are then sent to the NASA Administrator. What are the Committee’s thoughts on today’s presentations? Mr. Wood said he for one is very excited to see the proposed work on the X-planes. It’s a way for the younger generation to be involved: “I commend you. You guys have really gotten something going here.” Dr. Shin said that was one of the most exciting aspects of it. If ARMD gets approval, he thinks this will really motivate the younger generation. Ms. Blakey said the paradigm may be changing back: “It’s an interesting time for aerospace itself. NASA needs to think about the revolution that will happen.” Dr. Vos said that, indeed, the revolution is happening.

Dr. Clarke said that, in terms of NextGen, the Committee should say there needs to be an aggressive target and instituting a focused effort. It’s certainly a different strategy than Apollo, even though there are similarities. Dr. Vos said he definitely agreed with that: “To me, this becomes really powerful. A huge industry will develop around NextGen.” Ms. Blakey asked if Dr. Vos was saying the principles behind UTM are the same ones behind NextGen and one can build it up like a wedding cake. Dr. Vos said yes, some of the elements are very well aligned with what NextGen can become.

Dr. Francis said that in terms of UAS, some of the smallest machines will be flying in the most congested airspace. Dr. Clarke said that if UAS works in Manhattan with all those urban canyons, then anything can be tackled, maybe even a new “Manhattan Project.” If that problem can be solved, then it opens up entirely new prospects. Dr. Vos said that starting small, at low altitudes where no one will be displaced, is an ideal place to get everything going. It lines up very well with NextGen-plus. Dr. Clarke said it’s a prototyping and testbed. Dr. Vos said he agreed 100%. But it needs to move beyond that and become real. Dr. Sha said there needed to be a new certification process and a new airworthiness standard, and not just collaboration with the FAA, but innovation as well.

Dr. Clarke said that, when working the FAA traditionally, anything new must be proved. One example is fly-by-wire: one does the analysis, tests are conducted, safety is proved, and a certificate issued. One must develop the case so the system can be certified. NASA needs to be the UTM part. Dr. Sha said one thing has been overlooked: the whole thing has to fit into the entire certification process, and there's no automatic guarantee.

Dr. Vos said he agreed with Dr. Clarke. NASA has led UTM and is looking beyond. There are a number of companies focused on airplanes. It would behoove everyone to move ahead quickly. The U.S. should lead this with systems that can be validated in short order and incorporated into the existing airspace infrastructure. It can make a huge dent and would solve an issue that would occur during that first collision. Registration is step number one. Figuring out how to get the genie back into the bottle is a really powerful message to Congress, the public and the world. Ms. Blakey wondered if that observation could be put into the language of a recommendation.

Dr Shin said that everything all of the Committee members have said he wants to see. ARMD is managing a huge speed bump with the FAA. They think ARMD is developing a new air traffic management system and have said, "No, you are not [going to do that]." The sensitivity is very high on the FAA side. The whole next phase of NextGen is a very good idea. If the Committee wants to put this on the level of a recommendation, then he would need language to talk to the FAA. Ms. Blakey said it would be a proving ground to make sure the system will be safe. Dr. Clarke said that prototyping is the word he used. If it can be kept to that level, that may be acceptable enough.

Dr. Vos said he has been in this conversation very closely on both sides. The way to brake that is to go to the FAA, link arms, and say everyone needs to work together on this. Finding the right words is important, but the point is more important. It's an olive-branch opportunity. Together with industry, ARMD can help solve this problem. Dr. Shin said that ARMD asked the FAA to participate in the [NASA Unmanned Aerial Systems Traffic Management Convention, or UTM 2015, held July 28-30 at NASA Ames Research Center in California] but they said no. There are two camps in the FAA: One is progressive and Dr. Shin can work with that camp. NASA can play a significant role if industry says it needs NASA's help. But given the history, ARMD can't play the part of the big bad wolf here.

A discussion ensued about the drawbacks about creating a nonprofit to be an advocacy group. It's premature to make UTM a recommendation. Dr. Vos said that his company made progress behind the scenes with the FAA by not going public. Dr. Clarke wondered about establishing a finding that UTM is a potential testbed. Dr. Vos said the topic shouldn't be dropped, but worked more. Ms. Blakey said NASA will never be called to Capitol Hill and beaten around the head and shoulders about UAS and UTM. The FAA will take the heat, and "we have to be very responsive to that." Dr. Francis said he agreed with everything Dr. Vos said, but "you guys are thinking about the right things. And you have the right pieces [in place]."

Dr. Shin said he liked today's discussion because out of the [now dis-established] Joint Planning and Development Office work, a NextGen vision was developed. Now the FAA is working hard to realize some part of that. But beyond 2020, it's blank. Then what happens? ARMD has a golden opportunity to fill that 2020-and-out bucket with the right content. He praised Dr. Vos' idea as refreshing, because ARMD can accelerate, and in

a non-confrontational way. Dr. Clarke said there was the potential to create a place where ARMD can test benefits and concepts relatively inexpensively. Dr. Francis said that a government agency that's relatively well-known can bring the pieces together.

Ms. Blakey said she thought the Committee had three findings. The first is that the Committee is very excited by the X-planes program, its overall impact and its impact on the younger generation. The second is on the potential for UTM on low-altitude UAS, and a contributing factor and building block for NextGen. The third is ARMD's 10-year budget strategy and the environmental aspect.

Public Comments: None.

MEETING ADJOURNED at 4:23 p.m.