



NASA Advisory Council (NAC) Aeronautics Committee

July 28, 2015
Jet Propulsion Laboratory, Pasadena, Calif.

Summary of Meeting Minutes

[SUBMITTED by JIM SCHULTZ 10-9-15]

Participants:

First	Last	Organization	Role
John	Borghese	Rockwell Collins	Vice Chair
Dr. Michael	Francis	United Technologies R Center	Member
Dr. Missy	Cummings	Duke University	Member
Dr. Lui	Sha	University of Illinois	Member
Tom	Wood	Bell Helicopter	Member
Mark	Anderson	Independent Consultant	Member
Dr. Karen	Thole	Penn State University	Member
Brenda	Mulac	NASA ARMD	Executive Secretary
Robert	Pearce	NASA ARMD	Dep. AA Strategy
Akbar	Sultan	NASA ARMD	Dep. Director, AOSP
Dr. Shon	Grabbe	ARC SMART-NAS	Manager, SMART-NAS Project
Doug	Rohn	NASA ARMD	Director, TACP
Dr. Woodrow	Whitlow	Cleveland State Univ.	Co Chair, NRC Low Carbon Study

Tuesday, July 28, 2015

The meeting was called to order at 9:04 a.m.

Introductions

NASA Advisory Council (NAC) Aeronautics Committee Vice Chair Mr. John Borghese welcomed members and thanked Ms. Brenda Mulac for assuming executive secretary duties. Mr Borghese introduced Dr. Steven Squires as head of the NASA Advisory Council. Dr. Squires said the important work takes place at the committee level, and extended his great appreciation for the effort being put in. Advice issued by the various NAC committees has been streamlined and is now a two-tiered process. Mr. Borghese then informed the Committee that Aeronautics Research Mission Directorate (ARMD) Associate Administrator Dr. Jaiwon Shin was in attendance at the Unmanned Aerial Systems (UAS) Traffic Management (UTM) conference at NASA Ames Research Center and would not be attending as a result. Mr. Borghese also indicated that Gen. Lester Lyles was unable to attend this meeting because of a personal conflict, and Committee Chair Marion Blakey had another pressing commitment that prevented her attendance.

Ms. Mulac informed the members the next Aeronautics Committee meeting will be on November 12, 2015, and will take place in Washington, D.C. at NASA Headquarters. ARMD Deputy Associate Administrator for Strategy Mr. Robert Pearce welcomed the Committee and said there is a huge amount of value generated by these meetings. As usual, all findings and recommendations will be reviewed.

Interagency Partnerships by Mr. Akbar Sultan

Mr. Sultan said that partnerships are an essential part of NASA's Aeronautics activities. Typical entities that are engaged are grouped in three parts: academia, government agencies, and industry. NASA ARMD's role is to leverage, lead and collaborate. He pointed out that ARMD's international partners are government-funded institutions in specific countries. Agreements are established with foreign government agencies that may bring other partners with them. The government entity is more of a nexus; there are no foreign universities engaged.

Mr. Mark Anderson said that it was an area that gets grayer every day. Partnerships are obviously very important to ARMD, but the world keeps changing. Mr. Pearce said that it is not just a matter of expertise; it also has to do with assets. ARMD thinks long and hard about each partnership: is it really unique? He said that NASA is adopting the "leverage, lead and collaborate" model, and will be doing more leveraging outside the normal scope. Dr. Michael Francis, citing worldwide activity in unmanned aerial systems (UAS), said that the United States is not the leader.

Mr. Borghese, in citing ARMD's composites research, wondered what was the right word: "lead" or "collaborate?" Mr. Sultan replied that it was some of both. As an example, Mr. Sultan pointed out that for work on the Pultruded Rod Stitched Efficient Unitized Structure (PRSEUS) "cube," NASA is leading; for the PRSEUS "box", it is collaborating [with The Boeing Company]. Mr. Pearce then identified several coming collaborations in ARMD's Advanced Composites Project.

In response to a question posed by Dr. Karen Thole regarding technology readiness levels (TRLs), Mr. Sultan said that if one did an average across ARMD, leveraging occurs mostly for low TRL research, where as ARMD leads primarily mid-level TRL research, and collaborates for high TRL research. Advanced air transportation concepts may be in mid-TRL if a proposed collaboration with Airbus goes forward. There are not bright lines between each definition. Mr. Pearce said that in terms of NASA's electric propulsion research, battery technology will be leveraging, not leading. TRLs will vary depending on the effort.

Dr. Francis asked about how NASA will mold and shape its future workforce. He said he thinks that partnerships would play a huge role. This mechanism is a way to bring in new talent. Mr. Pearce said it was a great comment, and ARMD thinks about it often. Mr. Tommie Wood asked if the strategy was public. Mr. Pearce said yes and that ARMD would make it available to the Committee. Dr. Francis said in terms of partnership considerations, information technology is very different than traditional industrial systems. It's really beneficial for NASA to see how two different technology areas can be reconciled, especially considering mobile platforms like UAS, which are important to leverage.

Mr. Pearce observed that it takes a good deal of time to get to a traditional X-plane; far too long, in fact. A brief discussion then ensued concerning the length of time it takes to get prototypes into wind tunnels and to engage in flight tests. Mr. Borghese said that one major barrier in partnering is the contract process. Mr. Sultan commented that the process may not be inhibiting, but it does take a long time to get contracts and partnership agreements in place. Dr. Francis said that ARMD should have the ability to execute contracts in weeks, not in months. Mr. Anderson asserted that NASA can bring its unique abilities to bear and really change the process. NASA should take great care in forming partnerships and choose wisely. The agency employs very clever people who work in great facilities.

Dr. Missy Cummings said that NASA has a responsibility to be involved in unmanned aerial vehicles traffic management and provide guidance to partners that may not have as much experience. Mr. Pearce said that ARMD is asked to testify in front of Congress when unmanned aircraft issues arise. Dr. Cummings said that the Federal Aviation Administration (FAA) can't do UTM; NASA is the only place where this expertise exists. There is a clear gap, and NASA should jump in and fill that gap. Small or large UAS cannot be commercialized until NASA expertise is fully applied. Dr. Francis said that "NASA has a leg up. This UTM initiative is a good one and you need to keep going." Mr. Pearce replied that ARMD is committed to doing just that, and is starting to think about how to show the entire integration from ground to flight level. Dr. Francis advised to make that process as seamless as possible.

Dr. Cummings expressed concern that UTM is not given the level of importance by NASA that she felt it should and that it requires more resources. Dr. Francis countered that ARMD does understand [UTM's importance]. Mr. Sultan said that UTM is wrapped around the broader autonomy scope, and is a core first step toward autonomy. ARMD is fully committed to UTM. However, he pointed out that at this stage, the project can only absorb a finite amount of resources. Mr. Pearce said that UTM went from idea to funded project the fastest he had ever seen: it took less than a year. Dr. Cummings said that in her opinion the commercial sector doesn't see NASA as a serious player and

collaborator in this and that NASA is seen as an impediment to work around. A discussion then ensued about the FAA's role.

Mr. Borghese said that what ARMD is doing in UTM he believes will be revolutionary. Eventually the resources will come together. Mr. Wood then raised an issue about UAS noise, ie one drone is relatively quiet but many generate more noise. Dr. Cummings said she didn't think anybody was actively working that issue.

Dr. Francis said that companies treat their investors as the primary customer. Research and development has decreased significantly. When NASA goes into an agreement, it should be strategic for both parties. Because it's about NASA's future, any proposed partnership should get directly to the boards of directors. Companies need to identify where things are going in the long haul. Mr. Pearce cited ARMD's Environmentally Responsible Aviation (ERA) Project as a positive experience. However, there was a supplier who fell far behind in delivery of a test part. Even though the primary partner insisted on delivery, it still took several months. Dr. Francis said that it was the back-of-the-line mentality as far as research is concerned. Mr. Borghese suggested that ARMD's next meeting with aviation industry CEOs should include discussion of this issue.

A discussion ensued about tech transfer and data services. There is a lack of specificity of terminology, which is a concern. The term autonomy in the national airspace system (NAS) is different from Mars Rover autonomy; specific definitions really matter. Mr. Pearce cited extensive definition of products and deliverables, and said ARMD is attempting to apply previously successful methods to these new areas. The intent is not to create a lot of sandboxes. ARMD wants to be specific about applications and how they help in the NAS. Mr. Sultan said he agreed; although the titles could be more focused, the activities in each is very focused. The discussion continued about terminology and its use in describing autonomous systems and practical application. Money can be wasted if things are not properly defined.

Mr. Borghese wondered how ARMD successfully transitions technologies. Does the FAA say the work is finished or is it implemented? Mr. Sultan said it was both. A discussion then followed about how the FAA integrates NASA-delivered technology. The FAA approach remains ad hoc; information provided by NASA allows the FAA to eventually make a definitive decision. The FAA needs to tell NASA what it needs, not how to do it. The FAA does remain a "flat veto" organization, with as many as 20 different departments having the ability to say "no."

In response to a question posed by Dr. Thole about ARMD's work on energy innovation, Mr. Sultan said the research is an example of a partnership strategy. Mr. Pearce added that ARMD wants to maintain a broad tradespace. But some ideas are more mature than others. A group is currently working on laying out an overall roadmap.

Global Air Traffic Management by Akbar Sultan

In citing international collaboration, Mr. Sultan explained that there is a difference between interaction and collaboration. NASA wants to leverage unique capabilities, and is looking for complementary but not overlapping research. Face-to-face meetings remain essential. Fleet aging is another notable issue. ARMD is looking at testbed possibilities worldwide.

In response to a question from Dr. Francis about the involvement of the French organization Office National d'Etudes et Recherches Aérospatiales (ONERA) and its involvement in assistance to ARMD's Shadow Mode Assessment Using Realistic Technologies for the National Airspace System (SMART-NAS) Project, Mr. Sultan replied that the difference was that ARMD does high-level TRL work and ONERA is focused on first-principle work. ARMD is attempting to use their approach to inform the SMART-NAS simulation plan. Dr. Shon Grabbe, technical lead for NASA's traffic flow management research activities, said that ONERA's work is "about the how and the where. Human-automation teaming isn't the sole focus, but is a piece of the overall research." ONERA provides the low-level TRL triage.

Dr. Lui Sha said he wanted to echo Dr. Francis' comments. The most useful thing is to compare constraints. Is ARMD operating with the same profiles? Adverse interactions identified late in any program are serious issues. Potential structural issues can easily arise from non-rigorous computerized aircraft design. A discussion then ensued about pre-competitive concepts and simulation levels, and industrial partners. If tech transfer occurs, it occurs for a U.S.-based industrial partner. Dr. Thole expressed concern that by investing in foreign partnerships, NASA may be missing opportunities to invest domestically in the U.S.

Dr. Sha said he would like NASA to have a bigger budget, but [the Committee has] no control: "If we spread ourselves too thin, then we're not competitive anyway. We cannot do everything. Some core competencies cannot be compromised [whereas] secondary things can be outsourced." Dr. Sha cited [former CEO] Jack Welch and how he turned around General Electric. Mr. Sultan said he wouldn't bypass a domestic capability. If that capability exists, ARMD engages. Dr. Sha said that truly unique isn't possible. How can the U.S. keep its core competencies strong? Sometimes it is much better to collaborate.

Dr. Cummings inquired about the work that ARMD is conducting with ONERA and expressed concern that they may not be the right partner for the work identified. Mr. Sultan emphasized that ONERA has expertise in the foundational aspects of the research and that is being leveraged by NASA.

In response to a question posed by Dr. Thole on what the vetting process on the technical side is that NASA uses to identify viable partners, Mr. Sultan said that ARMD holds technical workshops and identifies the program objective. He cited simulations as one reason ARMD is working with ONERA: ARMD has worked short-term with them on previous efforts. Dr. Sha observed that the approach was a process solution and agreed with Dr. Thole that the key is vetting. He suggested that setting up a vetting committee made up of researchers would be better. The researchers could go meet with potential partners and make recommendations based on their findings.

Mr. Anderson said that it wasn't a good idea to fund ideas without the needed technical rigor. When the objective becomes collaboration at all costs, one gets in trouble. A discussion followed about collaboration being informed by technical expertise. It's a question of putting the best players in place. Mr. Pearce said that aeronautics is now a global enterprise, not just on a product basis, but on a research basis. ARMD's Airspace Operations and Safety Program (AOSP) is the first attempt to take a more strategic view on how ARMD should partner, and not on an ad hoc basis. Dr. Francis said he remained concerned that a dilution of research funds occurs with international collaboration.

In terms of potential future collaboration, AOSP has reached out to KLM Royal Dutch Airlines. Dr. Cummings said that KLM is the best company to team with. A discussion then ensued about how best to collaborate. The luxury business jet business might be a good opportunity. But the rub comes when taking the aircraft out of service in order to equip it for research.

Shadow Mode Assessment using Realistic Technologies for the NAS (SMART-NAS) for Safe Trajectory Based Operations (TBO) Project by Shon Grabbe

Mr. Borghese asked if trajectory based operations occur from gate to gate. He said that there are much larger problems one needs to understand during descent. Dr. Grabbe replied that the project was looking at the surface piece, the arrival piece, and trying to work through the integration issues, when one scheduler gives up control and passes it to another. The effort is to evolve beyond the Next Generation Air Transportation System (NextGen). Mr. Borghese said that there are three reasons for delays: weather, system outreaches when the Federal Aviation Administration (FAA) goes down, and the complexity of metroplex operations. Is the project addressing those?

Dr. Grabbe responded that that was the spirit of the effort. Bringing in weather uncertainties, especially when automation breaks down, will be a huge piece of the research. The regional part, the metroplex, will focus on the flows of traffic, not just on the Terminal Radar Approach Control (TRACON) boundary, but across the nation. Weather is usually ignored, but it makes up about 70% of the problem. Dr. Sha cited known incidents in a place like New York: "We have a wealth of records about all kinds of incidents. Establishing a team to pin down a data-driven approach for something like loss of separation would be more successful. It's hard to have a high-quality model for a complex system. Look for an actual risk and then [devise ways to] stay out of it." Dr. Grabbe said, "Well, yes and no. We have some data-driven elements in there. We're chipping away at some of the tall poles. A lot of this work is looking at an hour before departure. We're not de-conflicting for loss of separation."

Dr. Francis said that Dr. Grabbe mentioned going past NextGen. To what degree is the project looking to conduct out-of-the-box work? One example may be future co-piloting when the co-pilot is handling 10 airplanes. There may be a value proposition there that the project could explore. Dr. Grabbe said that hadn't yet occurred. Mr. Pearce said that the ultimate goal of SMART-NAS is to create a plug-and-play environment. But the funding only goes so far. Mr. Borghese said that if the project was doing evaluations of new concepts, particularly with weather, previous instances should be examined. Dr. Grabbe agreed, saying that the research wasn't focused on real-time only. Researchers want to "shadow," although that's not the only mode they will work in. Dr. Thole asked if the research would ultimately get to a cost and identify more efficiency. Dr. Grabbe

replied that regardless of whether the effort was monetized, metrics remains a huge part, as is leveraging capabilities.

Dr. Sha said that the areas that would be valuable for this Committee to understand are integration risk and technology risk. How will the project manage the contingencies, and what will be done when certain areas of pursuit don't pan out? Dr. Francis said that project researchers are "trying to wrap their hands around the future [so] I'd cut them a little slack in knowing where all the risks are." Mr. Borghese said that after a year or two of concerted effort, a different route may be followed. As scenarios are run, the resultant data may send the project in a different direction. Dr. Cummings said that the outcome of the research could be of use to academia if it's open source. Dr. Grabbe said that was where the project was going, although he didn't know the exact computer language that will be used. Starting early next year, the project intends to find a group of core users to work through the details of what is and is not feasible. Ultimately, such individuals could be part of [computer-based] demonstrations. The project wants to reach out to the community and make data usable. Dr. Cummings agreed: "Making it easily accessible is the key."

A discussion then ensued about ARMD's Future Air Traffic Management (ATM) Concepts Evaluation Tool, known as FACET. The new work would be community-based, with clean application program interfaces (a set of computerized approaches for building software applications), known as APIs. Problems related to International Traffic in Arms Regulations (ITAR) have cropped up before. There is a need to modify algorithms, so that the code could be improved. That would require a back- and-forth between NASA and users. NASA isn't providing all the tool kits, but the basic architecture. But: How will NASA move it and make it alive? A good template might be jet engine research conducted at Glenn Research Center. The exact mechanism isn't yet known, however. ARMD would like to get this research to a point where the value proposition kicks in. There is ongoing work to build toward tech transfer and sustainment. NASA may, however, want to retain the ability to pull it back; there should be more than one off-ramp. Although ARMD will continue to have a key interest, ARMD doesn't know yet how the code can or will be commercialized. There has to be a compelling business case for a company to take it on. The problem that has to be solved is how to make the air traffic management system more efficient. It's a valuable effort, so perhaps NASA should retain it. The potential value is very high.

Mr. Borghese observed that automation can play a major role in functional allocation. Mr. Pearce said it was at a relatively low technology readiness level. ARMD looked at it two years ago, and maintains a strong capability at NASA's Langley and Ames Research Centers. Dr. Francis said that the answer obtained today is not the one arrived at two years down the road, and definitely not the one reached five years down the road. Technology continues to change. Dr. Sha said that the risk is mitigated by an open-architecture approach, and getting the community involved early. Dr. Cummings said that approach can backfire too. Involve the air traffic control union, and there will be pushback. Dr. Sha asserted that by the time research was completed, the technology could be obsolete. Technology is always going to change, Mr. Borghese said. Dr. Francis wondered that if something is allocated to a machine, what is that going to do to the system? It becomes a series of what-if scenarios. Mr. Pearce said ARMD has been asking this question for a long time. There has been a long time since there has been a change to roles in the air traffic management (ATM) system. But he believes ATM can and will be improved.

Mr. Borghese asked when this type of research will be integrated into the national airspace system. Dr. Grabbe said it was “beyond NextGen; 2030, maybe. We won’t end up with a single recommendation, but a suite of them with associated metrics.” Mr. Pearce said that, by 2018, if the research is successful, ARMD could enter into a research transition team (RTT) agreement with the FAA. Then there would be another five years for development. Mr. Borghese said there needed to be some “drops” with these longer timelines. Dr. Sha suggested that it would be good to have some media management, to focus on real-world questions being answered and to get reporters and news organizations involved.

In response to a question by Dr. Francis about involving a private organization with ARMD’s UAS research, Mr. Pearce said he would not be sure about the fallout, but he expected at a minimum some kind of good, solid relationship could be developed. A discussion then ensued about privatization of UAS operations. It could be beneficial in the long run, but could also affect [NASA ARMD] budget allocation. A precedent for such an arrangement is the special agreements between and among airlines that already exist.

Dr. Francis said that there will be a need to eventually integrate with what gets done at lower altitudes and what gets done at higher altitudes. How might these things integrate? Communications is very important. Dr. Grabbe responded that his project is looking at alternative architectures, different than what exist today. An integration initiative will take place; if ARMD can’t do it internally, it might be opened up to others via a NASA Research Announcement (NRA). Dr. Sha said that such an effort could enhance NASA’s image to the public. Dr. Thole said the Committee has talked about involving the public in some way. Dr. Sha said that if the public understands, Congress may be willing to put more money in. Mr. Pearce said that, in the last couple of years, ARMD has settled on a solid strategy to communicate where NASA aeronautics research is going. ARMD will conduct unmanned aerial systems traffic management (UTM). A discussion then continued about UTM and public outreach. ARMD is doing what it can, but it also plays in the greater NASA agency.

Mr. Borghese said that what industry now sees is that the cost of delivering new certification was 30% and now it’s 60%. That increase is jeopardizing the entire airline industry. A discussion followed about certification costs, which are increasingly tied into the software side. Integration is a key issue. Dr. Sha said that researchers test models and assumptions: “We verify against a model, but the model can be missing things. Testing is vital; then formal methods can really pay off big. Nothing can replace the simplicity of the core function. Let’s look at all the major fails and all the facts. Formal methods and testing are complementary.”

Mr. Anderson expressed concern about top project risks. A discussion ensued about funding amounts for SMART-NAS Project resources. More money may be needed further in. It’s good that charts give a level of specificity, but top project risks remain quite worrisome. A plan is needed to resolve those risks. Otherwise, it needs to be pulled back to something that can be accomplished.

ARMD University Leadership Strategy by Doug Rohn

Mr. Doug Rohn said that in the case of a specific tech challenge such as demonstrating ceramic matrix composites for fuel blades to lower fuel use, progress may be plotted. But there is a need to listen attentively to university feedback. Many NRAs are smaller in terms of dollars and involve one principal investigator (PI), one professor and two grad students perhaps. Dr. Sha said that certain programs are so confined that fundamental innovations may be lost. Industrial research tends to be overly constrained. University folks tend to be under constrained. The lesson is understanding the problem formulation early, so that the two situations can be corrected. Cite success stories, manage the constraints, but don't manage the solutions.

Dr. Thole asked if there are longer-term commitments to universities. Mr. Rohn replied that there are perhaps three-to-five year agreements. Cost sharing is not a requirement. Dr. Francis said that centers of excellence may not produce a multidisciplinary effort. Mr. Anderson: "Is your plan to float competitive solicitations through all the [strategic] thrusts simultaneously?" Mr. Rohn: "We have not quite settled on that. We're asking universities to identify the critical challenges." Mr. Anderson said he could envision a scenario involving a variety of strategic thrusts, and if the universities come back with very different approaches, then ARMD would have quite a choice on its hands. ARMD would have to come to grips with whatever group offers the best solution.

Discussion then ensued about differing proposals. It's a complicated challenge; if professors are left alone to explore their own research interests, they will have fun, but NASA cannot allow that since it's a mission agency. It would be better to identify the functional gaps and go after the universities best suited to fill those gaps: get an idea of where partners can help ARMD. ARMD-underwritten NRAs will not go more than a few years, and a research roadmap should be required. ARMD has told universities that they need to take a more assertive role, gather critical thought leaders, and identify problems that they can solve. An integrated capability package is what is optimal. There is a need to know what the university's research strengths are. Funding is secondary; what is primary is trying different ideas. But money is needed to pay for graduate students and equipment. A two-step process could work: send a white paper, and if the funder is interested, the project will be funded. Internships should be encouraged as well.

Dr. Cummings expressed concern that university response to an ARMD request for proposals (RFPs) will be weak. Mr. Rohn said that there are usually many responses, specifically regarding proposal-related inquiries for additional information. Mr. Anderson said that ARMD might want to speak with individuals at the U.S. Air Force Research Laboratory (AFRL) on how the AFRL collaborative centers were established. There's a need to answer why industry would participate, and what's in it for them. Dr. Cummings said access to students might be one reason. Dr. Thole said that industry might want a university to establish a research strength in a given field of study.

Low Carbon Aviation Subcommittee by Drs. Karen Thole and Woodrow Whitlow

Mr. Borghese asked if the NRC study included both high bypass engines and open-rotor designs. Dr. Thole replied in the affirmative, but noted that both could be restricted on scope. Economic impacts are not clear. Both NASA and the International Civil Aviation Organization are studying low carbon aviation. In NASA's case, it parallels the ARMD autonomy study.

Mr. Borghese praised the subcommittee's findings as delivering a good, solid background. He said that, when looking at hybrid systems, two things will drive successful development: energy storage and high-density energy conversion. In terms of energy storage, next-generation batteries and supercapacitors are candidates. There was good expertise on the subcommittee team. Mr. Anderson said he was impressed with the subcommittee membership, but wondered why experts from Toyota's Prius group and Tesla Motors weren't included. Dr. Thole said that upcoming meetings would include such individuals. Dr. Francis said he had encountered the same thing before in another committee on which he served. Such people need to be added as committee members, not just as speakers. He also noted the Airbus interest in electric propulsion, and suggested bringing in an Airbus representative to explain the company's motivation.

Mr. Pearce thanked Dr. Thole and Dr. Whitlow for their work, and said that ARMD planned to do a similar study for each ARMD research thrust.

Committee Discussion

During the final portion of the Aeronautics Committee meeting, the members discussed their thoughts on, and opinions about, all of the presentations given to determine if a finding or a recommendation was warranted.

The discussion about the Interagency Partnerships and Global Air Traffic Management presentations centered around vetting of partnerships and having clear objectives to ensure the best partners are identified, especially when working with potential international partnerships. Mr. Borghese commented that there is a lack of clarity in the process for identifying potential partners and how these decisions are made. The members agreed with Mr. Borghese, and Mr. Anderson added that it is important to determine who the best partners are for a given expectation or objective. Is the purpose to work with the best in class, or is there another reason behind the partnership? The members decided that a finding on this topic should be developed.

During the final portion of the Aeronautics Committee meeting, reacting to the presentation made by Dr. Grabbe of the SMART-NAS Project, Committee members agreed it was very complete and very good, inasmuch as it contained a great number of specifics. Mr. Anderson said that the Committee is an advisory board, not a directive board. The project needs to come to terms with potential risks; at the moment, it isn't getting there.

Dr. Francis said that one of the things that made sense to him was that the project's work could be the basis for an X-program. Experiments could begin virtually and graduate to real-world demonstrations. It would be a way to demonstrate what is technologically feasible. Mr. Anderson said that available project resources seem to be inconsistent with the stated objectives. That may mean the project is trying to accomplish too much. Mr. Borghese wondered if the project was wasting money on allocation. Dr. Francis said that it wasn't possible to see out to 2030; such envisioned work in that timeframe shouldn't be funded. Mr. Anderson said that what the project was attempting to accomplish is too big for current funding levels.

Dr. Sha said the project's organizational and management structure is complex. What they're trying to do is very ambitious. What are the secondary goals? Reduce the complexity or inevitably fail. Many software projects have too much complexity. Grand

features are useless if they're buggy features. One must identify the most fundamental requirements. Formal methods become useless. Anything that is as large and complex as software should involve the National Research Council. Eliminate all the unnecessary complexities. Mr. Borghese said the comments from Committee members should be incorporated into a finding.

In terms of university strategy, Mr. Anderson said that he applauded ARMD trying to move the universities toward leadership. Universities want grants; that's one end of the spectrum. The other end is leadership. Dr. Cummings said that leadership is important, but looking at [federal government] sequestration, people are in a very reactive mode right now. Mr. Borghese said there should be some level of guidance for the proposals. Dr. Cummings said she would recommend drilling down on the topics area. Dr. Thole said she liked the white paper concept. Faculty spend a lot of time on proposals. Mr. Borghese said that the approach taken by the Defense Advanced Research Projects Agency (DARPA) "is wonderful. If they choose you, they tell you how to proceed." Dr. Cummings said that she understands the impetus behind thought-leadership. However, she is concerned that the average professor won't be willing to do that kind of leadership.

Dr. Sha said he agreed: "You want to make people more aware. If you want more people involved, you need to notify university management to distribute it widely." Dr. Thole said she wasn't sure that would guarantee a response from professors. Dr. Cummings said that professors are focused on responding to NRAs because of the funding associated with them. Mr. Anderson complimented ARMD on their efforts to reach out to the universities on this topic. Dr. Cummings suggested that ARMD could take its strategic thrust areas and turn each into a white paper.

A discussion then ensued about a white-papers approach. The Committee will submit a finding. Mr. Anderson said that an after-action report might be useful to determine why any potential interactions didn't occur. Dr. Cummings said that university professors don't frequent the government website Federal Business Opportunities [where procurement listings that exceed \$25,000 are posted]. Mr. Borghese said it was a great first step, and Dr. Sha agreed.

Mr. Borghese said he recommended no formal finding be issued as regards the report made by Drs. Thole and Whitlow, and the committee members agreed.

No comments from the general public were made, and the Aeronautics Committee meeting adjourned at 4:45 p.m. Pacific Daylight Time.