NASA Advisory Council (NAC)
Meeting of the
Human Exploration and Operations Committee
Research Subcommittee

NASA Headquarters, Washington, DC

February 24, 2014

David E. Longnecker 04-29-2014
Chair

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Bradley M. Carpenter
Executive Secretary

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Research Subcommittee

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Opening Remarks

Dr. Bradley Carpenter, Executive Secretary of the Research Subcommittee (RS) of the NASA Advisory Committee (NAC) Human Exploration and Operations Committee (HEOC), welcomed the Subcommittee members. Dr. David Longnecker, Chair of the Subcommittee, then reviewed the RS charter, which states that the Subcommittee's purpose is to review and assess NASA's approach to research in support of human exploration.

Space Life and Physical Sciences (SLPS) Division Report

Dr. Marshall Porterfield, SLPS Director, described the Division's mission as effectively accomplishing science outcomes for NASA. In order to accomplish that, the Division needs new ideas and help in working with new concepts.

The SLPS portfolio encompasses space biology, physical sciences, and human research. Much of this activity applies to human exploration beyond low Earth orbit (LEO). An example of this content is research on the biological effects of space radiation. The Division also collaborates with the International Space Station (ISS) Program and the Center for the Advancement of Science in Space (CASIS). Dr. Porterfield reviewed the SLPS organizational chart, noting that the Division works closely with NASA's Chief Scientist, Dr. Ellen Stofan, and her office.

Space biology focus on model biological systems to see how the space environment affects living organisms such as plants, rodents, and fruit flies. The human research program develops scientific and technological solutions to problems that face humans in the space flight environment, which has several profound effects on human health. Risks to human health and performance are carefully documented, and mitigation strategies are defined and implemented. Work in the physical sciences area ranges from fundamental science to engineering research solutions. An example is cryogenic storage and the science required to engineer advanced systems. The Decadal Survey (DS) provides research priorities as assessed by the National Research Council..

The budget is split between two elements: Human Research, which is within the Exploration Research and Development line, and biological and physical sciences, which is under the ISS program. The NASA Fiscal Year 2014 (FY14) budget request has a separate line for human research, with an allocation of about $160 million. The ISS budget includes a line for ISS research; about $75 million of this is for biological and physical sciences, as well as CASIS.

In the area of research and flight project planning, major new efforts include the geneLAB, materialsLAB, Cold Atom Lab (CAL), Rodent Research Mission, Fruit Fly Lab, and new plant research hardware. The Division is moving to a more open source science (OSS) approach that offers the community greater opportunities for research rather than putting all of the focus on a single principal investigator (PI). OSS facilitates training and allows for innovation to leverage output.

There are hardware developments planned through 2020. A detailed graphic illustrated the physical sciences development schedule, with payloads and project milestones reflecting the availability of flight hardware. Dr. Porterfield described the progress of CAL as an example. Each element on the chart has its own unique limitations of hardware and/or crew. Costs differ by area.

A comparable chart for space biology featured regular research announcements. The flight program includes much rodent research. Microbiology experiments are part of the microbial observatory, a DS recommendation. SLPS is also doing fruit fly research, as about 700 of the 900 genes associated with human disease are also found in fruit flies. Space biology has relatively lower investments in experiment-specific instrumentation when compared to the physical sciences. While there is some hardware, it more often enables a series of experiments rather than a single experiment; the hardware is less hypothesis-centric.

SLPS made it through sequestration with minimal impact, although there were some scheduling issues and a few funding disconnects with ISS. A more stable, predictable picture would help avoid the disruptions that could affect research and schedules. Anything that negatively affects the schedule will increase costs and decrease what can be done in the future.

Congress has shown interest in the various levels of science produced from ISS, as well as its role in society and the benefits to humanity. SLPS briefs Congressional committees and individual staffers on the productivity of the space program. The public often has unrealistic expectations for short-term payoffs from space research, the length of time it takes to develop vaccines being an example. Another example is the liquid metal or amorphous metal produced with the help of research performed in the Space Shuttle program – it was 20 to 25 years before that discovery was commercialized as a component of future iPhones. Therefore, in dealing with Congress and other stakeholders, SLPS must periodically explain the timelines. The budgets for commercial flights also affect what can go up to and come back from ISS. SLPS is collaborating more with CASIS, and bringing the organization in early to help identify where more fundamental work is necessary.

Programmatic accomplishments include the transition to the OSS concept and briefings on geneLAB and the materialsLAB. SLPS also conducted a quarterly review and has 10 experiments set to be launched on SpaceX3. Various Division staff supported the American Society for Gravitational Space Research meeting and the International Symposium for Physical Sciences. The Office of Science and Technology Policy (OSTP) initiatives for open data and publications have been helpful in supporting the move to OSS and in communicating the change to the research community and Congress. The expectation that a PI can run an experiment and hold onto the work indefinitely is coming to an end. The OSS model is the same one used for the Hubble Space Telescope (HST). Both OSTP and the Office of Management and Budget (OMB) have been overwhelmingly supportive.

Discussion

- *Dr. Longnecker* would like to get a sense of what has been planned and where SLPS is in relation to that. *Dr. Porterfield* agreed to develop that information for RS.

- *Dr. Kathryn Thornton* asked for the status of the budget for SpaceX. *Dr. Porterfield* replied that it falls under the ISS budget. The schedules for what ISS can buy are problematic and affect SLPS research.

- *Dr. Stein Sture* noted that the life sciences schedule appeared more predictable and even than the physical sciences schedule. *Dr. Porterfield* explained that the physical science experiments are active in terms of hands-on and crew time, but life science work is more about exposure to the environment. OSS is fueled by genome sequencing technologies on the life science side.

- *Dr. Katherine Banks* asked how NASA plans to avoid duplication with other government agencies in the area of materials. *Dr. Porterfield* said that he would address that in more detail later in the day, but did note that the workshop scheduled for April is being coordinated with the National Institute of Standards and Technology (NIST). SLPS is actually ahead of NIST on database development. The Materials Research Society is another co-sponsor, and the Department of Defense (DOD) and corporate partners are involved, as is CASIS. *Dr. Longnecker* thought that Dr. Banks raised an important point. A key of the coming meeting goes beyond the discussion to whether the joint activities actually get implemented. Such discussions can lead to real activities, and he would like to see that sort of outcome downstream from this initiative with NIST. As budgets tighten, the need to coordinate and avoid duplication is essential.

Role of Research in Human Exploration and Operations Mission Directorate (HEOMD)

Mr. William Gerstenmaier said that HEOMD wants to shift the way in which the Directorate does research. For example, data from the HST are available for researchers to review, so instead of one investigator conducting research, there are various perspectives from multiple grants examining a rich data set. He sought RS feedback on this.

He would also like to see more focused research on how human performs in microgravity. ISS will help understand issues that could affect longer-term, more complex journeys. For example, NASA is now good at dealing with bone loss, but the devices are bulky, and there is a need for something smaller. The human research program has identified 40 or so risks that should be resolved before embarking on a human flight to Mars, for example. This was one of the reasons the extension of ISS was necessary.

ISS is also a research platform for a range of NASA divisions and directorates, including the Science Mission Directorate (SMD). CASIS is active in determining commercial applications for ISS research discoveries. For example, pharmaceutical companies are interested in some ISS discoveries addressing bone loss. ISS allows pass/fail tests of drugs on rodents in space, providing answers more rapidly than would be possible on Earth. We may never again have a space station of this magnitude, but the commercial side may build other space stations that are smaller and from which NASA can buy time.

Discussion

- *Dr. Sture* raised the issue of materials design. *Mr. Gerstenmaier* explained that NASA is reaching out to the National Science Foundation (NSF) and others to see if they are interested in using ISS. *Dr. Porterfield* added that there is currently no NASA support for materials design, but the materialsLAB will be driven by the community to target classes of materials. The SLPS vision is that once the materials are created and their properties are in a database, the informatics will lead to more work in this area.

- *Mr. Gerstenmaier* gave examples of some of the research. A standard laboratory protein crystal growth device was flown to ISS to see if it works there, which it does. The preliminary x-ray diffraction data from the protein crystals that were produced was sent back to compare with terrestrial results. What was significant here was that scientists did not have to learn a new instrument, as they were using a familiar device. This kind of thing lowers the barrier to entry and allows for direct comparisons without the need to interpret differences. *Dr. Longnecker* added that it also eliminates a source of variability in the results. *Mr. Gerstenmaier* said that this is one of the means through which ISS allows new research in novel ways. All of the international partners' equipment is available for use by NASA.

- *Dr. Longnecker* asked for more details on the ISS extension to 2024. *Mr. Gerstenmaier* said that engineers current think that ISS will last to 2028. The additional 4 years help researchers with their planning windows. *Dr. Porterfield* added that, for rodent research, the centrifuge recommended by the DS would be too expensive if the ISS ended in 2020. The extension allows for longer use that justifies the investment.

- *Dr. Longnecker* asked whether this stability fosters more interest from university-based researchers. *Dr. Sture* was emphatic that it does, providing support for post-docs and labs. *Dr. Banks* added that it helps in bringing in young scientists, who are not interested in a program that may not exist in 5 years.

- Regarding informatics and "big data" for material science, *Dr. Sture* explained that much of this has come from condensed matter physics, which receives a great deal of support from the Department of Energy (DOE). *Dr. Porterfield* observed that the informatics constitute a tremendous challenge that the workshop will help address. On the bioinformatics side, the National Institutes of Health (NIH) has databases with gene chip data and other data that are stovepiped; NASA seeks to break that down and bring in industry to look at integrated "omics" tools. High performance computing is addressed in some ways, but looking at arrays of data is more challenging. This is not an Agency-level agenda item, but it is important to SLPS.

- When asked how RS can help, *Mr. Gerstenmaier* replied that he would like the members to look at what HEOMD is doing with the longer horizon for ISS and see if anything can or should be done differently. The Directorate is getting projects up much faster and streamlining the safety processes, but input as to the members' own research and how microgravity could help further it would be useful. He would also like to know of any synergies they see.

ISS Resource Planning

Mr. Samuel Scimemi, NASA's ISS Program Director, addressed resource planning, which has two areas, strategic and tactical. Strategic plans are documented and reviewed with international partners. Tactical planning grows out of strategic plans.

ISS can start integrating payloads at any point in the planning process according to user needs, and some payloads can be integrated very quickly. An example of this would be commercial equipment. Loading begins about 1 month prior launch. One carrier can load mice and other living things up to the day before the launch, as was done on the Space Shuttle.

Research sponsors on ISS include various divisions within NASA, along with CASIS and international partners. Russian research is a parallel activity, though the two sides integrate as needed. NASA considers full ISS utilization to include everything that supports utilization, including crew time, sample return, power, etc. Factors affecting the resources include changes, anomalies, hardware failures, and more. To get the most out of ISS, NASA continues to expand each resource when it becomes limiting.

The funding is broad, and comes from internal and external sources. It also changes over time, as with SMD, which went from almost nothing on ISS to spending many millions of dollars on Station payloads. NASA is trying to be more nimble with science payloads. A 2013 review polled current users, and the feedback was mostly positive. Much has changed over the past 10 years.

ISS has a great deal of utilization data. For example, 84 percent of the racks are utilized, though external slots are at only 50 percent. However, the requirements for the latter are more complex, and most of the best external sites are claimed through 2020. Crew time is oversubscribed; this includes use of crew members as human subjects. Their availability needs to be expanded, and NASA hopes to collaborate with Russia on this. The onset of commercial crew flights will help with this. Regarding “upmass” and “downmass,” there is no backlog on the ground now, but demand will outpace capabilities by 2015. Spacecraft power and cooling and environmental control systems are among the pertinent issues here.

The ISS has very detailed records on all of this, which Mr. Scimemi illustrated with graphics that showed the instruments located on external payloads and the crew time. In 2017, the NASA side will add a fourth crew member. Current crew time comes to 42.6 hours per week. ISS now has more efficient ways to load and offload cargo on ISS. The program has worked through operational scenarios in order to allocate more time to utilization and less to “housekeeping.” About 80 percent of crew time is for NASA activities.

The ISS payload philosophy is to fly and operate payloads as soon as they are ready. To operate ISS as a lab, the program needs to enable flexibility for investigators to adapt their research plan based on new and unexpected findings. The goal is to continue making integration and operation of payloads on ISS as simple and ground-like as possible. Upgraded resources include the air-to-ground data system and internal racks. Data rates are about equal to those of the cable companies, and they are being upgraded beyond that. Human research, physical sciences, technology demonstrations, and astrophysics are mostly if not all run by NASA, while biology/biotech, earth sciences, and education are split with the national lab.

Additional capabilities that are funded and in development include projects in cell science, genomics, fundamental physics, life science, materials science, and more. The program is looking at improvements like simplified express racks, additional payload sites, greater data feeds, and live animal return. The program is also evaluating new capabilities through 2024, and is considering other sites externally for non-standard payloads. The payloads that can be added to a launch quickly tend to be small, while larger projects require more strategic planning.

SLPS Division Report continued

Dr. Porterfield resumed his presentation by reviewing space biology accomplishments. Rodent research is a key area of interest, as it overlaps human research and human health research. The Division is working through some NIH compliance issues in developing science requirements and complying with regulations. This is an area in which CASIS helps, as its customers must meet these requirements. SLPS has reconstituted the animal care activities that had been done at Kennedy Space Center (KSC). A fruit fly lab, cell biology capabilities, and other capabilities are being developed. Work continues on a Phase A mouse centrifuge feasibility assessment, a science cell hardware versus science needs survey, and a Russian rodent research post-flight sample analysis. The Japanese Space Agency (JAXA) is considering modification of a centrifuge to support rodents, so NASA may end up partnering on that.

The CASIS chair, Dr. France Cordova, is stepping down, as she has been nominated to be the new NSF director. No new chair has been identified yet, but the board has added new members. Former astronaut Gregory Johnson is now the executive director. The strategy for business development is evolving to incorporate relationships in research hotbeds like Silicon Valley and Boston. SLPS and CASIS want to do more effective hand-off of research and identify more areas of common interest. The SLPS fundamental science fuels the work done at CASIS.

Planned activities in the programmatic area include FY14 phasing plan activities. There are 10 experiments in development for SpaceX, and SLPS is looking at how to use the ISS extension to 2024. In the physical science area, the Division will hold the materials workshop in April, and is resolving funding issues, conducting the CAL preliminary design review (PDR), and beginning experiment operations for investigations launching on Space X3. CAL will allow investigators to cool atoms and probe their quantum properties. This is fundamental physics that will lead to the ability to manipulate atoms for nanotech or quantum computing.

The focus in space biology is on strategic planning for geneLAB. Other activities have to do with rodent integration and the animal care facility. A key DS recommendation was to do a 1G centrifuge with animals. Possible studies coming out of this could include dose response to gravity levels.

Discussion

- *Dr. Longnecker* asked whether the confluence of the space biology area and omics work could validate some ground-based models. The validated models would offer a tremendous advantage. *Dr. Porterfield* agreed, noting that that is part of the plan for geneLAB. NASA want to do a full study of "loaded" versus "unloaded" samples to determine ground analogs and see the similarities and differences. This will help distinguish between the data and the noise, and will lead to the enabling of ground-based derivative experiments. There are similar opportunities in physical sciences. CASIS is working to speed the translation of ISS research, which involves validating models so that work can take place on the ground, offering the benefits of speed and accuracy. This is why SLPS includes CASIS well in advance of the planning stages.

SLPS Research Planning

After a break for lunch, Dr. Porterfield discussed SLPS research planning. Plans are based on recommendations received from a number of sources. Human research content is driven primarily by the identified risks to human health and performance. Biological and physical sciences content reflects advisory group recommendations, including the DS.

The Institute of Medicine (IOM) has identified about 40 risks to human health and performance related to space travel. There is a schedule to use ISS in finding solutions to each of these. Dr. Porterfield showed a chart indicating the relative progress in addressing each risk. The need to mitigate these risks is one of the justifications for the continuation of the ISS through 2024.

The DS recommendations covered the entire range of SLPS projects. The program has rated the recommendations on a scale of 1 to 8 as to whether they enable human spaceflight or are enabled by human spaceflight. This information is available online. With 63 "highest priority" recommendations, SLPS has a lot to cover in its research portfolio.

The current model of how SLPS manages the NASA Research Announcement (NRA) process was reviewed. Proposals responding to an NRA are required to show how the proposed research applies to the DS. There are also steps involving peer review and a flight research requirements assessment for feasibility. Program executives look at additional criteria and make recommendations for selection, which then go to the appropriate field centers.

ISS has been innovative in making space and time available, but there are logistics and funding limitations. OSS will create more opportunities for investigators to use ISS by defining envelopes of research that can be developed and making raw data available to the community. Next-generation informatics approaches are being developed to enable discovery. The program does not want data just sitting in a database; the intent is to enable access and use. SLPS is also addressing how to incentivize use of the data, enabling hundreds of efforts developed around different hypotheses. Open access to research data is a growing issue in Federal R&D, as demonstrated by recent OSTP policy.

Through OSS, SLPS begins with a plan and oversees the scientific requirements. NASA then performs the experiment and manages payload integration. ISS flight experiment operations lead to sample return for high-content analysis. The last step is the space informatics database, which is where OSS applies and which is the multiplier. Grants will be for ground-based experiments based on what investigators find in the database. While enabling many ISS-derived investigations, OSS will also lead to new scientific insight and publications, and create competition in the community. Those who use the data best will be the most competitive, while outside users will cite the database as a reference.

This model reflects the longstanding practice with the HST, in which observational data is collected and shared. High content screening is a platform for high density/high throughput life science utilization of ISS, and it conforms to the DS, which recommends use of more advanced omics technologies. High priority studies include developmental programming, epigenics, and omics systems biology approaches.

The phased development plan has not yet been updated to go through 2024. SLPS is looking at analytics capabilities first. The materialsLAB OSS campaign is the first effort in this area, starting with the workshop in mid-April. SLPS is already reaching back to the PI community and getting raw data to populate the informatics database. Theme areas include metals, semiconductors, polymers, etc. The database is based on the Athena database managed at Marshall Space Flight Center, so it is not entirely new. The database is highly searchable, populated with spaceflight-derived data, capable of meta-analysis across omics channels, and linkable to existing data sets. The pipeline for data collection involves ground proof of concept, piggybacking on existing NRAs and full geneLAB missions. Many of the initiatives underway are in response to the DS.

Discussion

- *Dr. Banks* asked if there might be incentives for companies to participate in OSS, especially in light of the increased interest in commercialization. *Dr. Porterfield* replied that SLPS hopes to offer innovation grants and have the investigators identify how the proposed work furthers the targets for development. SLPS involves industry early in the process through CASIS. There is a lot of interest commercially in medical informatics and linking omics technologies, but there is not yet a standard dataset, which is something NASA can do.

- *Dr. Robert Altenkirch* asked about the financial aspect, noting that experiments take a long time to develop, and it was not clear where the money would come from for a large number of PIs. *Dr. Terri Lomax* pointed out that there would be less hardware development, freeing up funds for additional researchers. It was also noted that OSTP had not yet released its policy when SLPS first mentioned OSS. The NASA policy will be published within a number of months.

- *Dr. Sture* said that maintaining and managing such a database is a huge undertaking, and costly. Collaboration and back-up should be arranged to the extent possible. *Dr. Porterfield* explained that the commercial side, through CASIS, is interested in supporting this. SLPS is talking with DOE and other partners to minimize the funding impact. There is already an allocation for access to the supercomputing facility at Ames Research Center (ARC). NIH has succeeded with a broad mission supporting thousands and thousands of investigators; this will be smaller. The database will build up, and the challenge will be not so much about data storage as about the next generation of informatics tools.

- *Dr. Longnecker* noted that while this sounds exciting, the downside could be that scientists do not want to invest great resources into open data and prefer having it to themselves for a while. *Dr. Lomax* said that there are ways for the proprietary material to go through the national labs. The data are not what is valuable to the PIs, it is what they can do with the data.

- Regarding the 63 high-priority recommendations from the DS, *Dr. Longnecker* wanted to know what was most perplexing. *Dr. Porterfield* replied that bioregenerative life support is a glaring omission. The Environmental Control and Life Support System (ECLSS) on ISS uses harsh chemicals and takes up a lot of crew time. It becomes bio-fouled, which aligns with a microbial recommendation. *Dr. Gale Allen*, NASA's Deputy Chief Scientist, said that when NASA looked at the 200-plus DS recommendations, representatives from all of the centers and disciplines were brought together. They examined two scenarios to assign weight to the recommendations, then established priorities based on budget and looked at synergies and existing investments. That was the first wave. The next step was to integrate further.

- *Dr. Longnecker* said that, regarding bioregenerative efforts, he hears that the big issue for Mars is radiation, but it seems that bioregenerative life support efforts would also be limiting factors. A lot of the work points downstream.. *Dr. Steve Davison* of SLPS said that this is a complicated question. The radiation health standards that must be met will be challenging. IOM is reviewing NASA's current risk standards and looking at how the risks might be dealt with. In the meantime, the research program is looking at the cancer risk model with some updates. The epidemiological data must be examined, for example, in light of the fact that most astronauts have never smoked, yet the lung cancer risk in deep space escalates after about 550 days for males, with fewer days for women. New data are coming in for cardiovascular risk as well. How NASA incorporates those data is an issue, since they come from the use of nuclear bombs in Japan in World War Two. Another unknown is the central nervous system, for which there are only animal data. It is not yet clear how to translate that to humans. It may be difficult to fly astronauts with experience because they already have exposure and the acceptable risk has not been determined.

- *Dr. Porterfield* said that the Subcommittee should note that access to animal models has been missing, limited by launches and crew time, among other factors. *Dr. Davison* then explained the twins study. While both NASA and the Russians will be extending some research that has involved two subjects, NASa also realized that one of the astronauts on the schedule has an identical twin brother. This presents a unique opportunity, which the twins have agreed to support. SLPS put out a research announcement, which received a good response; NASA is now making selections. This is something new, and it asks a lot from the crew members. The twins have had genetic counseling, and they must decide if they want to do this – if either one objects, the project will not go forward. The mission is scheduled for 2015. As the terrestrial partner has flown into space before, this is not a fully controlled experiment. There are many variables that cannot be controlled.

- *Dr. Sture* referred to recent research indicating that some important gender differences are greater than previously assumed, making research complicated. *Dr. Thornton* gave the example of dosing with Ambien. The research on that drug was done on men, but women respond to it differently. *Dr. Davison* noted that there has been some study on male/female differences, but in terms of bone loss, they are similar. One problem is the limited number of subjects.

Public Comment

Members of the public were given an opportunity to speak to the Subcommittee, but no one came forward.

Committee Deliberation

Dr. Longnecker asked the Subcommittee members to develop a response to what they had heard throughout the day. Dr. Carpenter explained that the NAC has two major products: findings, which do not call for a response from NASA; and recommendations, which calls for a specific action by NASA.

Dr. Sture began by suggesting a recommendation that NASA continue to be a strong collaborator with other Federal agencies in all areas of science, including data curation and management. NASA should reach out to NIH, NSF, DOE, and others. Awareness of what is taking place is important. The consequences of not doing this revolve around issues of efficiency. Unless NASA is proactive in collaborations, the Agency risks redundancy and falling behind in important areas. Dr. Lomax added that there would be lost opportunities for synergy as well.

Dr. Altenkirch thought that was too generic. He asked whether the OSS for ISS had been analyzed to see if anything useful can be done within the available time. Dr. Porterfield replied that the analysis has been done, and a reverse analysis shows that by not doing giant data grabs while ISS is still operable, the science community loses the opportunity for ongoing analyses. The time to prepare is known, and the completion of one good rodent experiment alone would justify it. One reason for the April workshop is to identify classes and targets for materials. This is another reason SLPS is reaching out to other agencies. Dr. Sture said that it is never too late. The goal is optimum use, but there is no need to wait for the ideal situation. Dr. Altenkirch observed that there must also be a plan for winding down the work. NASA could sink a lot of money into this and not get a sufficient return. Dr. Sture added that the Association of Research University Libraries has been thinking about this topic for a long time. It is confounding, especially when setting priorities. It is important to catch the data before it is too late.

Dr. Altenkirch thought the window of opportunity seemed short, and wondered if a young scientist would really invest time in this. Dr. Porterfield explained that part of the purpose of OSS is to increase the lifetime of output from ISS, so that the data will be analyzed long past the end of ISS operations. SLPS has determined OSS to be practical in this timeframe. He gave the example of geneLAB-based experiments to be done by end of 2015, which will produce data that will populate the database in about 2 years. Dr. Carpenter added that the working hypothesis is that the data set from the first rodent flight, scheduled for 2017, will be sufficient on its own to support the research database. Dr. Altenkirch pointed out that there is no such experience on the physical sciences side. Dr. Porterfield replied that SLPS can go back and gather past data, which the PIs have already volunteered to give to the program.

The hope is that investigators will use the database and substantiate it with outside data. There will still be opportunities for single-PI experiments, though those PIs would have to provide some data to the community. Dr. Banks mentioned the standard protocol, in which data sets are pulled together and compared. Dr. Porterfield said that this is where SLPS will communicate with the community, get input, and have a dialogue. There will be a need to do quality control as well. OSS is not a new creation. SLPS will do what the big pharmaceutical companies already do in regard to high-content screening. Much of this is in place. The goal is to be nimble in gearing up.

Dr. Longnecker felt like RS received very valuable information about OSS, but he was concerned about the level of support for informatics. It was unclear as to whether NASA would support it or whether there were systems in place for someone else to support it. Dr. Porterfield said that this is a key challenge on the life science side. NASA has identified partners, like NIH, that will help the Agency do this more effectively for a longer period of time. However, this collaboration is not yet fully established.

Dr. Altenkirch asked about intellectual property rights (IPR) issues and CASIS. Dr. Porterfield said that OSS may fuel CASIS to do some work, but the commercial partner will own it. The current law states that if NASA sponsors research, others can use that research without paying for it. Dr. Carpenter added that NASA has bipartisan Congressional support to provide a specific exemption for ISS research.

Dr. Longnecker reviewed the ideas that had been mentioned to see if the Subcommittee wanted to write them as findings or recommendations.

1. Collaboration with other entities is essential for the success of proposed activities and is essential to being cost-effective.
2. Dr. Altenkirch asked if the aspirational vision been tested against an operational plan for feasibility.
3. There are questions about big data informatics and whether there is appropriate support to foster the OSS approach.
4. Dr. Banks suggested looking at OSS, but not limiting funding to that model.
5. Dr. Banks wanted a standard protocol so that data can be interpreted appropriately.
6. Dr. Altenkirch had questions about IPR.

Dr. Longnecker suggested that the sixth point might fold into operational plans. Dr. Altenkirch pointed out that IPR can cause arguments between nonprofit and commercial partners. A number of universities are no longer keeping their IPR because it is a nuisance to defend this. Commercial interests will say they own what they paid for, but they fail to note that they used 30 years of effort from nonprofit entities.

Dr. Thornton suggested having an overall finding in support of OSS, and listing residual concerns. Dr. Longnecker said that he would draft the finding with her and circulate it to the Subcommittee for comment via email by the end of the week. Dr. Banks thought it would be a good idea to state support for upcoming workshop on materialsLAB.

Dr. Carpenter reminded the Subcommittee that Mr. Gerstenmaier had asked them to look at the research plan and provide feedback, identify areas that should be opened up but are not, and talk about what it takes to open up those areas.

Dr. Sture observed that there is a drive to ask scientists to think about payoff, which is usually beyond the horizon for basic science. NASA is always responding to the urgent pleas of politicians to state an outcome and a timeline, but he would like to see the Agency take a stand on basic science. NASA should create some good responses and language on why it is done. The Agency has been bold in the past. It is myopic to always focus on the big payoff. NASA looks deep and far, never at trivial issues. Investigators should have the freedom to look forward instead of stating what they have found that can be used. Basic research primes the pump for what comes later.

Dr. Altenkirch added that NIH and DOE do basic research, but they have defined missions that are clear to the public. He wondered if the general public today knows NASA's mission beyond putting people into space and exploring. Basic research links with the mission of exploring beyond Earth, but there is no plan to put people out there. If that were known, the general public would not complain about doing basic research. Dr. Porterfield added that at a meeting of the American Society for Gravitational and Space Research, a Chinese delegation disclosed plans for a space station. They are building on NASA's publication record and matching it up point by point. That presentation video is available, as is a PowerPoint summary. This has gotten a response from Congress.

Dr. Sture said that he would like a recommendation to spell out that NASA should support these disciplines. He and Dr. Longnecker agreed to develop something together.

Adjourn

Dr. Longnecker thanked the Subcommittee members, and adjourned the meeting at 3:23 p.m.

Appendix A
MEETING ATTENDEES

Committee Members
Present
Chair: Dr. David Longnecker
Dr. Robert A. Altenkirch
Dr. M. Katherine Banks
Dr. Terri L. Lomax*
Dr. Stein Sture
Dr. Kathryn Thornton
Executive Secretary: Dr. Bradley Carpenter
Administrative Officer: Ms. Shawanda Robinson
**participated via teleconference*

NASA Attendees
Gale Allen
Steve Davison
Richard Irving
Eracenia Kennedy
Marshall Porterfield
Samuel Scimemi
Ellen Stofan

WebEx Participants
James Dean
Abby Dickes
James Johnson
Jackie Joinis
Dan Leone
John Limperis
William Mackey
Juergen Nittner
Aaron Oesterly
Brent Patterson
Bette Siegel
Marcia Smith

Appendix B

Research Subcommittee Members

Dr. David E. Longnecker, C*hair*
Association of American Medical Colleges (AAMC) and member of the National Academy of Sciences Institute of Medicine (IOM)

Dr. Bradley Carpenter, *Executive Secretary*
NASA

Dr. Robert A. Altenkirch
The University of Alabama in Huntsville

Dr. M. Katherine Banks
Texas A&M University

Dr. Jeffrey A. Hoffman
Massachusetts Institute of Technology

Dr. Terri L. Lomax
North Carolina State University

Dr. Stein Sture
University of Colorado at Boulder

Dr. Kathryn Thornton
University of Virginia

Appendix C
Presentations

1. *Space Life and Physical Sciences (SLPS) Status,* Marshall Porterfield
2. *International Space Station Research Resource Planning,* Sam Scimemi
3. *Space Life and Physical Sciences Briefing to the Research Subcommittee*, Marshall Porterfield

Appendix D
Agenda

NASA ADVISORY COUNCIL
RESEARCH SUBCOMMITTEE MEETING
NASA Headquarters
Room 7H41A
Washington, DC 20546
Monday, February 24, 2014

<u>Committee Public Meeting</u>

9:00 a.m.	Opening Remarks	Dr. Longnecker
9:10 a.m.	SLPS Division Report	Dr. Porterfield
10:00 a.m.	Role of Research in HEOMD	Mr. Gerstenmaier
11:00 a.m.	ISS Resource Planning	Mr. Scimemi
12:00 noon	Lunch	
1:00 p.m.	SLSPRA Research Planning	Dr. Porterfield
2:00 p.m.	Public Comment	
2:30 p.m.	Committee Deliberation	Dr. Longnecker
4:00 p.m.	Adjourn	