Directorate for Mathematical and Physical Sciences (MPS) Advisory Committee Meeting
November 30, 2020 (all times EDT)
National Science Foundation
2415 Eisenhower Ave, Alexandria, VA
Room E2020

Summary Minutes

Monday, November 30, 2020

Advisory Committee Members in Attendance (All Virtual):

Dr. Anna Balazs
Dr. Susanne Brenner
Dr. Robert Bryant
Dr. Tabbetha Dobbins
Dr. Miguel Garcia-Garibay
Dr. Lynne Hillenbrand
Dr. Catherine Hunt
Dr. Robert Kirshner
Dr. Cornelia Lang
Dr. Herbert Levine
Dr. Jennifer Lewis
Dr. Andrew Millis
Dr. Jill Pipher
Dr. William Tolman

Call to order and official opening of meeting, FACA Briefing – Catherine Jones, Sean L. Jones, Acting Assistant Director, MPS; Kathleen McCloud, Staff Associate, MPS; MPSAC Chair

The meeting was opened at 12:30 pm by Dr. Catherine Hunt. It began with a discussion of Zoom best practices by Dr. Hunt. Dr. Kathleen McCloud provided a discussion on the policies of the Federal Advisory Committee Act regarding conflicts of interest for AC members, as well as a reminder that the meeting was open to the public and occurring under the guidelines of FACA. The minutes previous meeting, held in August 2020, were approved unanimously by the members of the AC by a motion introduced by Dr. Hunt.

Update: MPS – Sean L. Jones, Assistant Director, MPS

Dr. Sean L. Jones, Assistant Director for Mathematical and Physical Sciences, provided an update on the state of the MPS directorate. Dr. Jones provided an agenda for the rest of the meeting. Dr. Jones highlighted staff changes within MPS including Tracey Kimbrall joining as Acting DDD position on a detail. The Deputy AD position has been advertised, has closed and NSF will try to review candidates in the near future. Dr. Clark Cooper will retire as Senior Advisor this year and NSF will look to find a new Senior Advisor. Dr. Jones highlighted actions taken during the August 18, 2020 MPS Black Lives in Science Panel; this file can be accessed from the MPS Broadening Participation website. Dr. Jones discussed the Nobel Laureates recognized in 2020 who were funded by NSF including awardees of the Nobel Prize in Physics (Andrea Ghez, Roger Penrose and Reinhard Genzel). Dr. Jones highlighted the breakthrough in room temperature superconductivity which NSF funded. Dr. Jones reviewed the Big Ideas Mid-scale Research Infrastructure 2 Award program. Dr. Jones discussed progress made in fostering the Industries of the Future initiative. Dr. Jones provided an update on COVID-19 and NSF's current response to it. Dr. Jones covered the MPS FY 2021 budget including the continuing resolution status and the NSF budget requests of the President, House and Senate. Dr. Jones provided a recap of the status of the Arecibo detector platform and NSF's planning to

decommission the 305 m telescope but not the overall facility. Dr. Jones discussed NSF's 2022-2026 Strategic Plan planning process and timeline towards final publication in February 2022.

Question: Robert Kirshner asked about the Arecibo facility. What is the observatory without the telescope? What steps is NSF taking to mitigate impact to ongoing science programs?

- MPS answer: Dr. Sean Jones: NSF is focused on the safety of the people and the structure at Arecibo and decommissioning plans that can be safely implemented.
- AC answer: Dr. Ralph Gaume: Arecibo has two LIDARs in operation; the one on site will continue to operate. A geographically separated LIDAR exists on a separate island off of Puerto Rico. A 12-meter Patriot dish onsite at the observatory is used in geodesy and geodetic sciences but has never been fully operational. NSF has funds to repair that dish and make it fully operational. NGVLA may be funded for three 18-meter dishes in Arecibo and three additional 18-meter dishes in the Virgin Islands. Arecibo is important to the people of Puerto Rico as a beacon of STEM and science in general so the planned decommissioning will emphasize saving the visitors center / STEM outreach center which is directly under one of the towers that might collapse.

DMS COV Report Presentation – Russel Caflisch, Director, Courant Institute, New York University and Tatiana Toro, Craig McKibben and Sarah Merner Professor, University of Washington

Drs. Russel Caflisch and Tatiana Toro presented the final report of the 2020 Committee of Visitors (COV) to the Division of Mathematical Science (DMS). The COV Committee met virtually with DMS on Sept. 6. The Highlights: PI's who are supported by DMS are more likely to receive prestigious awards and recognition during period of review. Equality, Diversity, and Inclusion: We were nicely surprised by this. This was a truly diverse COV. There was a remarkable increase in diversity among Program Officers.Proposal Review Process: Central to DMS's mission. The process works well overall.

Recommendations:

1. Encourage virtual Panels, even after pandemic ends.
2. Broader Impact Criterion. It could play a stronger role in funding decisions. Consistency could be improved.
3. Improve the quality and consistency of reviews and panel summaries.
4. Collection of demographic information.
5. Consider resubmission of grants proposals
6. Equality, Diversity and Inclusion.

David Manderscheid: Institutes provide an opportunity for PI's and Researchers to collaborate. We are very impressed with how DMS is supporting this Program.

Recommendations:

1. Institutes should receive more support from DMS.
2. Institutes should be encouraged to publicize
3. More data on under-represented groups.
4. We encourage DMS to fund more Institutes

Discussion and Vote on Acceptance of Chemistry COV Report

Question: Did you have specific ideas for increasing Broader Impacts?

- Perhaps a list of 5 questions that need to be answered for all proposals
- Sean Jones: To answer the question, it is something we've dealt with for a while. Articulating thoughts and ideas in the Strategic Plan may be a way of doing it.
- Perhaps additional training for mentors. We do have a Broadening Participation Working Group.

Question: Is the fraction of DMS support appropriate or should the balance be adjusted?

- With a caveat, yes. More students should be funded. We should also ask who they will support and their grant would depend on that. DMS is putting more emphasis on Grad Students and Post Docs.

Question: Congress is discussing expanding the scope of NSF's mission. Asking the COV, the way DMS manages Institutions, would they be able to handle this should the government decide to do this?

- David Manderscheid: Program Officers have placed great emphasis on this. I have every confidence in their ability to do that if needed.

Catherine Hunt would like to ask Jill Pipher her opinions of the COV.

- Jill Pipher responds that working on COV's is an amazing experience. She supports the idea of allowing resubmissions. There are excellent proposals that can't be funded and its very discouraging.

The DMS CoV 2020 was approved unanimously by the members of the AC by a motion introduced by Dr. Hunt.

MPS and the Living World Update—Catherine Hunt, MPSAC Chair, University of Virginia, Linda Sapochak, MPS/DMR, and Jennifer Lewis, Subcommittee Liaison, Harvard University

Dr. Katie Hunt presented an introduction to the new subcommittee on "MPS and the Living World," going over the membership, the charge for the subcommittee and inviting discussion on the group as it begins work next month. The members represent all MPS disciplines, have a mixture of experience in academia, industry, and the national labs, and meet broadening participation objectives. They include:

Rommie Amaro, University of California, San Diego
Virginia Cornish, Columbia University
Nebojsa Duric, Wayne State University
Moh El-Naggar, University of Southern California

Anthony Guiseppi-Elie, Anderson University
Trachette Jackson, University of Michigan
Chaitan Khosla, Stanford University
Ka Yee Lee, University of Chicago
Herbert Levine, Northeastern University
Jennifer Lewis, Harvard University
Sherine Obare, North Carolina A&T, University of North Carolina, Greensboro
Jeff Pixton, National Radio Astronomy Observatory
Dagmar Ringe, Brandeis University
Ralph Rosenzweig, Georgia Institute of Technology
Linda Sapochak, National Science Foundation
Willian Tolman, Washington University, St. Louis
Eranthie Weerepana, Boston College
Neil Woodbury, Arizona State University

The charge of the subcommittee is to:
- Harness capabilities of MPS to enable the future of biotechnology
- Build transformational collaborations across MPS and beyond
- Advance research in industries from agriculture to medicine, electronics to energy, advanced manufacturing to digital communications, as well as biotechnology

The subcommittee will be focused on a few key areas of inquiry: What are the fundamental questions that need to be answered? Which of the questions are unique to MPS fields? Who do we need to partner with to advance the field? How can biotechnology advances in turn advance MPS science? The general expectation is that the group will engage in visioning of what the world will be like if we do the "right work." Then they will go back and figure out the steps to reach that vision, iterating, as necessary.

Discussion of MPS and the Living World Discussion

Cornelia Lang asked about whether the subcommittee would address the educational piece of biotechnology and MPS. Katie answered that how we train students to work in the intersection of MPS science and biotechnology will be one of the fundamental questions.

Herbert Levine noted that the physics division has an example of adding a specific graduate education component to similar work that could serve as a model. Katie agreed that the group would not reinvent the wheel if there were good models to recommend.

Anna Balazs asked about the definition of biotechnology for this effort. Katie quoted from other material. Sean Jones said that the plan is to match the definition used broadly by NSF, so as to allow for integration of the subcommittee's work into NSF plans and programs.

Jennifer Lewis noted that there is a good example of this type of work from DMR where development in microfluidic platforms enabled sequencing at the single-cell level. Anna thought that such examples should be gathered in order to help introduce the subcommittee's work to the community.

Miguel Garcia-Garibay asked if the definition would include biomimetics. Jennifer thought it would not if the activity was 100% synthetic. Herbert suggested that would also exclude artificial neural networks. Katie said that for now, the group will be focused on gathering great ideas. The group can consider definitional issues later and, if necessary, pass good ideas to other parts of NSF.

Andrew Millis asked if there is a process planned for delineating areas of needed basic research to meet the needs of future applications. Katie said that she planned to start with visioning and then to work backwards to what needs to be done to make it happen, followed by iterating on the ideas and process. However, the subcommittee will make decisions on how best to proceed and she was reluctant to be proscriptive.

Tabbetha Dobbins noted that for the question, "What partnerships can advance the field?," the subcommittee should be sure and consider the role of large-scale facilities both in terms of utilization and partnerships to develop techniques and instrumentation. Katie agreed and said that the subcommittee will be encouraged to engage the community for such ideas.

Herbert said he still was not exactly sure how the subcommittee process will work. Katie said she wanted to leave it open to the members to help decide. Sean said that normally subcommittees hold workshops to produce reports that together become a reference for the community in responding to solicitations and developing projects. The subcommittee will determine what kind of processes to use to generate the reports and how to engage community expertise. Katie noted that the subcommittee will start work in December, 2020.

Implementation of community input on large scale NSF research infrastructure – Chris Smith, Senior Advisor for Facilities, MPS/OAD

- Welcome by Katie Hunt
- Introduction by RCS
    - Anticipating arrival of Astro2020 report, which sets priorities for astrophysics research infrastructure, among other things
    - Have been discussing how to engage AC, and didn't want a redundant "community report on a community report" – instead generally discussing importance of large infrastructure, not focused on specific discipline or project
- Major facilities are a cornerstone of MPS science
    - Roughly a quarter of NSF overall budget
    - Some science can only be done with specific instruments, expertise, locations

  - Multiplying effect of multi-user facilities
  - Platforms for scientific collaborations and innovation, in coordination with industry
- The need for large facilities has been recognized about as long as the need for NSF, and indeed was part of the justification for NSF
  - First awards for AST facilities in 1955, just 5 years after NSF's founding
  - Today, facilities, across a wide range of disciplines and geographies, remain a critical component of American scientific leadership
- Examples
  - LIGO: extremely specialized & sensitive instrumentation
  - ALMA: instrumentation, but also location (Atacama desert – high & dry); interferometry at unprecedented resolution
  - NHMFL: talented engineers and scientists – generations of world-record-setting magnet technology, needed for a range of disciplines, needs significant stable funding
- NSF is a world leader in research infrastructure, with incredible results:
  - Nobel Prizes in Physics: 2017, 2013, 2011 (LIGO, LHC, CTIO) – 3 of 10 this decade!
  - Required long-term, risky investments in infrastructure & people
- Success of facilities relies on community – ideas come from them! NSF puts heavy weight on community input, particularly in major reports.
  - Astronomy decadal led the way, with other decadals (e.g. P5), and other periodic reports (often sponsored by MPS divisions) following suit
  - MPS supports funding for the reports through workshops + NASEM, as well as for early development of projects (in partnership between individual investigators and facilities)
  - Overlaps b/w divisions & directorates: Astro2020 overlaps AST, PHY, OPP in scope; just one of the reports that will inform priorities over the coming decade
- Funding process for major facilities (MREFC)
  - Strong collaboration b/w NSF & community, starting with development funding as community crystallizes and coalesces around project concepts (1-10 years)
  - Implementation too large for DIR/DIV to fund – MREFC is a separate budget line, with specific Congressional appropriation outside of DIR/DIV budgets, usually dedicated to projects $70M+ historically, now $20M+ with addition of Mid-scale RI-2
  - But MREFC only funds construction – DIR/DIV pay for D&D, operations, divestment
  - Ops costs run ~10% of construction costs annually – but this varies by discipline and with partnerships
    - A lot has been said about rising O&M costs; NSF senior leadership exploring strategies for mitigation, with NSB and Cognressional input (exploring sustainable solutions)
  - Divestment – Recognize that we do have to make difficult decisions about closure, but also that the savings of closing older facilities doesn't balance out costs of next-generation facilities
    - Lessons from 2012 AST Portfolio Review – successful, but left a lot to be funded
    - Successes of CHEXS in DMR and NSCL in PHY (being passed to DOE) – possible paths that we continue to explore
    - Not a silver bullet for advancing to the next generation of facilities!

- Plot of MREFC TPC through time (since 1996) – costs have been increasing through time, even when inflation-adjusted.
  - Many next-gen facilities wouldn't fit on the plot ($1-2B) – this is an NSF issue!
  - Partnerships amplify investments, in some cases into the billions in total costs
- MREFC total budget has been mostly flat over the past couple of decades
  - CORF (and NSF generally) has started to think about increasing the MREFC funding wedge – motivating "aspirational, inspirational, and transformative science." Needed for NSF as a whole, projects as a lever for garnering support for science overall (including for those who use the facilities!)
  - MREFC is an NSF-wide resource: GEO, BIO (NEON), CISE (LCCF).
- MREFC requires a high bar – must be critical strategic priorities for NSF, not just one discipline, and therefore starts in Design Stage, prior to Construction.
  - Director's approval at every stage, NSB for passing preliminary & final design
  - Entry into process is a major milestone, can happen anywhere through preliminary design – represents indication of strategic priority at NSF/Director level. Just for entry, DIV has to convince Sean, MPS has to convince OD & the rest of the agency, and Director has to put out a memo to that effect.
  - Entry into process doesn't guarantee construction funding, just recognizes that it's a high priority and "on the rails" through the MREFC process.
  - Beyond NSF, have to work with OMB & Congress.
- Key element: translate community input into NSF critical investments and make that case

- Bringing to AC to ask for advice on making the best case and developing strategies for achieving needed funding. Also want AC support for implementing those strategies!
- Suggestion for an MPS AC Subcommittee
  - Very different than Living World: "community committee"
  - Look for more of a "voice of the MPS AC" on this issue – giving advice & support
  - Utilize MPS AC Subcommittee, looking more towards AC members and a few high-level external experts in science policy
  - Rapid timescale letter or report – almost in parallel to Astro2020
  - Not an endorsement of particular report, but rather generally of the centrality of such reports to global leadership

Discussion with Chris Smith

- Lynne Hillenbrand (AC): Notional ambitious MREFC profile – Mid-scale RI is included in here, is that MREFC? I thought it was separate.
  - RCS: Two tracks (1 is $6-20M, 2 is $20-70M). Mid-Scale RI-2 is awarded with MREFC funding.
  - LH: Should this notional budget not become a reality, should the subcommittee think about how to divide the pie in a flat budget environment?
  - RCS: That's a lot of internal stuff – MPSAC supporting this MREFC wedge would actually be very important in making this wedge come true. Provides MPS and NSF with

the ammunition to make the larger wedge happen. If it doesn't happen, we will have to curtail efforts.

- Tabbetha Dobbins (AC): What is the flat MREFC budget plot representing? Includes O&M?
    - RCS: No, this is construction budget only. O&M is within R&RA funding line.
    - SLJ (MPS): MREFC line is a separate ask. Appropriators have asked us for estimated costs of future projects; notional profile helps Congress to understand what a world-class infrastructure portfolio would cost.
- TD: Is there a hope/plan for facilities to include industry partnerships in operations?
    - RCS: Yes, some do. MagLab has some applied aspects that can be leveraged. Telescopes are a bit harder to engage industry. But yes, facilities do look for industry partnerships, as well as international.
    - SLJ: CHESS has some industrial and interagency partnerships. Opportunistic where it makes sense and is possible.
- Bill Zajc (AC): Produce letter/report by summer 2021 – who would the letter be addressed to?
    - SLJ: Trying to craft this story for our NSF/NSB colleagues. Will use with OMB as well. But internal stakeholders first! I envision this going to the Director, then being forwarded to NSB.
    - RCS: Can further discuss as we develop the charge.
- Robert Kirshner (AC): Don't need too much persuading. Chris hasn't emphasized how poorly the U.S. stacks up in the world. 3% of flat NSF budget is very different than European and Chinese colleagues – will be a bad thing on the horizon of a couple decades. U.S. stands to lose leadership in forefront activities. We should be worried about that. Context of great scientific progress is excellent. We better find our way forward, sooner rather than later. Won't happen with flat budget and flat MREFC percentage.
    - RCS: Exactly the message: this is important and urgent! CORF recognizes this, and we need all hands on deck to push for this wedge and solutions.
- Cornelia Lang (AC): Timing (chicken & egg) with Astro2020? I was part of AST Portfolio Review.
    - RCS: Because Astro2020 has criticality and urgency of advancing project, the point at which the AC's voice would be most impactful is kind of at the same time as Astro2020.
- Bill Tolman (AC): I would like to support this, but it is a zero-sum game. Shouldn't be at the expense of other things. Concerned about a strongly-worded letter of support, but not recognizing impact on other things.
    - RCS: Yes, that issue is always there. Fully expect the letter to have nuance and recognition of challenges. "This is important, not to the exclusion of other things." Would have to recognize that, and I have to agree with you. We have to have scientists funded to do science with these facilities!
    - Katie Hunt (AC): Absolutely about making the case for "Plan A," need to speak with an AC voice to these other pieces. I like the idea of a letter with supporting documents. Need executive summary with the "punch" up front.
- Jennifer Lewis (AC): Obvious strategy is to grow the pie, not just the wedge. Coupled with that, could think about increasing initial wedge as the pie increases.

- LH: To this last point, always making these balances, e.g. in AST Portfolio Reviews. Other point in support of what Robert said re: international aspects – previous decadal survey (Astro2010) specifically had a chapter on this. International collaborations are key – how does this sentiment continue to fall flat?
    - RCS: This attempt is part of that. Not to ding Astro2010 chapter, but that is an astronomy report, and that recognizes one field. This should be an MPS-wide (and eventually NSF-wide) conversation. Sean discussed with peers in GEO & BIO as well.
    - SLJ: Before embarking with AC, checked in with GEO and BIO. Also beyond AST in MPS! Looking at "all-community" approach, starting at MPS level. Other DIRs are 100% behind this approach, again not to the detriment of other science investments, but to maintain leadership.
- Robert Bryant: Question about strategy: assuming all the other DIVs are on board, how specific should we be? Good arguments are often specific. General culture of R&D and strategic investment is fine, but should focus on specific challenges and positionality of coming from disciplines across MPS.
    - SLJ: Right on target.
    - RB: Want to talk about past successes – doesn't predict future but gives a sense, should touch on this. To what extent should we focus on general vs. specific arguments? (Otherwise arguments look like carbon copies.)
    - RCS: Stronger if from whole MPS community, including opportunities for DMS (e.g. use of big data). And, while we explicitly don't want this to be an endorsement of the Astro2020 Decadal Survey, there is still a possibility to use this as an example of where investments in facilities are necessary for world leadership.
- Andy Millis: Interesting topic, but a tall order for 6 months. Hearing mixed messages, urgent timetable for Astro2020 and need to push forward AST projects, but also want a general statement with specific examples across MPS. This is a choice, as the latter is more work (e.g. to consider things like NQI, large-scale physics, CHESS support).
    - RCS: Agreed, noted, will consider in next steps.
    - CL: Thanks, Andy, for that question - that perspective is what I was after in my comment/question also! [from chat]
- TD: Nobel slides chose a narrow cross-section of results arising at facilities, but need to pull in broader swath of results made possible because of facilities (e.g. crystallography). Also re: zero-sum game, there is the facilities vs. other MPS investments angle, but also need to think about decision trees for some facilities vs. other facilities.
- KH: Are we taking a vote on whether we should formalize the charge by spring?
    - SLJ: No. We will take what we've learned here, and draft a charge to socialize with AC.
    - KH: Can't wait until next AC, should touch base in the interim. We will also share our notes/perspectives from this meeting.
- KH: AC members – send me an email if interested! (Tabbetha)
    - Thanks to Chris for the energizing presentation!

Closing remarks and adjorning for the day

Catherine Hunt thanked everyone involved in this meeting including the AC members, CoV members, and those from NSF. She adjourned the meeting at 4:15 pm EST.