Group #14: Community of Interest on the Future of Scientific Methodologies

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| Date | November 2, 2020 |

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1 Day One - November 2, 2020

1.1 Breakout 1 - Define the Scope of the Problem.

**The following participants have not been active:**  
Kate Evans

**Question or instruction for the discussion:**  
Breakout 1 - Define the Scope of the Problem.  
The purpose of this session is to lay the foundation for the next 5 sessions. That is, each breakout group will define a key piece of technology, a new device, or methodology that would have an impact on how the labs/scientists operate. The details should include answers to the questions below.



**Sticky points:**

 Top Takeaways (5 points per participant)

* What is the problem, issue, technology, device, methodology?
  + How can the lab complex change to encourage innovation at the interfaces between scientific disciplines when those interfaces live in the context of history and authorities. (#1)
  + Innovation is currently constrained by competition, the drive to get (stay) funded, and risk aversion. (#2)
  + Funding is so constrained that there is little room for radical innovation. Teams can not just form around a new idea and sustain. (#3)
  + Innovation is hindered by the lack of diversity and funding. (#6)
  + Topics for research are not just constrained to the DOE mission, they are also constained to the interests of the program managers. (#8)
  + Where appropriate Cooperation between Offices within the Office of Science (or participants funded by a particular Office) should be more encouraged (#9)
    - And between federal agencies (e.g. NSF - DOE collaborations can be challenging) (#11)
    - And across laboratories. (#14)
  + The credit and funding system pit individuals and small teams against each other across labs and within labs making it difficult to collaborate. (#12)
  + Diversity of staff is limited - a broadly diverse staff is more innovative. (#13)
  + Cooperation across federal agencies is more strongly encouraged than collaboration among labs. (#16)
  + The silos between agencies prevent innovatively solving big problems (i.e. BES and EERE) (#26)
  + We are also driven by metrics because our sponsors care about them. This can be positive but can also result in bad behavior (#36)
    - agree - need to be measured on teaming, impact, and innovation (#37)
  + (3) Discussion: A lot of commonality on the funding model, silos preventing cooperations, diversity challenges. Metrics that we live by (credit, proposals funding, paper writing - individual behaviors) don't necessarily equate to innovation. (#38)
    - Does innovation come only from individuals? Or from a team environment? (#39)
    - First authorship concerns. Publications of the future: data sets? Jupyter notebooks? (#40)
      * Writing style dictates your ability to succeed in science. If metrics change, opens up the door for others. (#41)
    - (1) Universities have a different model (individual-focused), which should also be supported because some individuals are more innovative outside the team environment. (#42)
    - (1) Ideas that turn out to be failures \*should\* be celebrated. That's real science. (#43)
    - National labs were created to solve a national problem in a time of crisis, that was supported. But we seem to have forgotten that legacy. Have we lost our purpose? (Are the labs focused on business volume rather than impact?) (#44)
    - National labs should not solve problems only during times of national emergencies. (#45)
      * Need to remove the constraints so we are focused on priorities all the time. (#46)
* Who would develop it (basic research to advanced deployment)?
  + The funding model at the national labs needs to be modified to enhance innovation (#5)
  + (1) Innovation must be driven "bottoms-up." Respective fields must find consensus within their own communities around ideas before they are elevated to priorities. (#15)
  + Collaboration between national laboratories and universities should be revisited to allow for more student experimentation/discovery. I believe this revision starts with the constraints placed by leadership in national laboratories, federal policy makers, and professors in academia - some of which are very entangled. (#21)
  + DOE (and potentially the federal government) should change their processes and reward mechanisms for high-risk high-reward research driven by innovation , but ultimately that innovation must behind at the grass-roots level. (#28)
  + Everyone needs to be involved at all levels. The current model in my field where researchers go off and develop new capabilities and then show them to potential users is the wrong approach. We need to partner together and build trust so that all the thinking can be in the conversation - basic researchers, applied researchers, and technical engineers. Program managers need to be part of the conversation too so they understand what and why. (#35)
  + (3) Discussion: Is this a problem that DOE needs to solve? Have to have all levels involved in a team, from basic research to development to deployment, to actually bring technology to fruition. Need to define our metrics to reward people along this pipeline, but our reward mechanisms are tied to DOE and what they value. (#47)
    - In academia, papers are important. Cross-collaborations are challenging - university wants papers, labs wants the applications. how do you make a project successful given differing evaluation structures. (#48)
* Who would use it and what skills would they need to use it effectively?
  + (1) The people involved in these intersections need to be trained \*in the respective fields being brought together\*. The myth of the "autodidact polymath" needs to be dispelled. (#4)
  + All scientific staff, and if done properly, support staff would benefit and be energized by the ability to be innovative in their mission at the labs. (#7)
  + Broad thinking "let's solve it" skills--"we can't do it that way" needs to be a phrase of the past (#29)
  + This is one particular area where new technology could make a real difference. There is a difference between domain knowledge and domain-specific jargon/tradition that could be ameliorated by technology (e.g. intelligent agents, data portals). (#30)
  + People will need skills in capabilities like design thinking and user research. Today we solve the problem we think is next. People need to learn to identify the next big challenge and how to engage in figuring out what needs to be done to solve it. This is not just strategic thinking. (#31)
  + (2) Discussion: We're not trained to listen to each other (we focus on telling each other). User-centered research Basic literacy in teams Can't train curiosity. Converting the thinking from individuality (academic oriented) to team focus (lab focus). Perhaps the NNSA has an edge b/c of their long-mission? Office of Science has a diverse portfolio that is more agile. (#49)
    - (1) Can we have Fellows that have a year to go spend time at different places? Work with different groups? Collaborations between labs happen when a long-term visit happens. Fostering longer-term collaborations / visits would help break down barriers. (#50)
      * How to make our networks between lab easier to navigate. Currently it's all who you know and who they know. (#51)
* When would it be expected to be in production use (N years in the future)?
  + Ideally, now. Realistically, our culture has become so constrained, in addition to major policy/model changes, culture changes will be needed--those take time (5-25 years), see last box (#10)
  + Sooner than later. We continue to face ever-complex problems where innovation is needed. (#25)
  + Ideally within 2-5 years. Without more innovation, we are falling behind industry in many areas. (#27)
  + Within the DOE, change can and should be near immediate. Realistically, breaking down barriers between federal agencies will likely take longer and require more buy-in. (#32)
  + Discussion: We have built this sociology for so many years that it will be challenging to break that down so quickly. Training - universities won't make a wild change from the individual-based research quickly. Need to create an environment that encourages training in teams-based environements Also need to train people to appreciate diverse thoughts / people (#52)
    - Opportunities to start up innovative large team projects (across agencies, labs, people) exists now. Can do these today (with appropriate people). Need to change the structural mechanisms for rewards. Existing mechanisms (e.g. EFRCs) exist, the end result is so constrained that innovation can be stifled. (#53)
    - (1) Average projects sizes are small. Some minimum funding level to enable a true team capability could be helpful. (#54)
      * Small projects are often the only place you get to innovate. (#55)
      * (3) Overhead of paying for the labs infrastructure to run the lab forces the project to be risk averse because the cost of the project is too high (can't fail). (#56)
        + Can the proposal mechanism actually fund the individual and the research idea. Not the entire infrastructure. Built into the system. Would like the lab complex to have teh operations of the lab built into the structure of the lab system funded by DOE. (#57)

Are there too many labs? So there isn't as much competition or redundancy of (indirect supported) capabilities. (#58)

* Where, and how widely, would it be deployed?
  + (1) Ideally throughout the scientific community--removing barriers between NLs and between federal sectors to promote taking on the biggest challenges together. (#17)
  + Throughout each lab breaking down the silos within the labs and enabling more creativity and innovation. (#22)
  + Creating that mission driven focus at NLs that brings every single staff person (scientist or not) to the table. At Universities this is clearly driven by an educational focus, but critical that the education emphasizes innovation in the process of productivity (#33)
  + Using a different perspective than people/labs, it should also be deployed at the entrance of any multidisciplinary research project. In these projects, many people bring established thoughts or practices from their respective fields. However, when coupling two fields, these established practices many be ineffective and innovation should be highly encouraged (enforced). (#34)
  + (1) Discussion: The lab complex is tribal - within sciences, labs, program offices, etc. Need opportunity to break down these barriers. NSF - has strong ties to the individual program managers. Have to know the personalities and what they're going to put out as their next call. PMs often listen to certain people within the communities. Interconnectts b/n the universities, labs, other agencies, etc. Needs to focus on improving these ties. (#59)
* What is the setup time and/or process for using it?
  + To modify the processes, 5 years. (#18)
  + To Modify the culture, 5-10 years (#19)
    - This would be a very fast transition! But, yes, should be the aspiration/goal. (#23)
  + To truly embrace innovation to transform the scientific community, 5-10 years (#20)
  + Structural modification might be able to happen quickly as we already see innovation for national emergencies. Sociological change will take longer. (#24)
  + (1) Discussion: Could happen today if structural mechanism in the labs were changed and reward mechanisms altered (#60)

1.2 Breakout 2 - Implications of this Problem.

**The following participants have not been active:**  
Kate Evans, \*fac- Nami

**Question or instruction for the discussion:**  
Breakout 2 - Implications of this Problem.  
Each group will now develop a list of issues and implications for the issue/technology/community they settled on. There are lots of implications for how a technology can be used, or further developed.



**Sticky points:**

 Top Takeaways (5 points per participant)

* What other/companion technologies, services, software/hardware must also be developed and deployed?
  + (1) Reasoning systems that allow practitioners from different domains to convey ideas and patterns of thought as transparently as possible. (#1)
  + Teleporting (seriously). Rapid transport between locations; collaboration space that is shared virtually but lets you interact in real time (thinking experiements here)--in part could be autonomous instruments, or could be two people connected, one on site, one off. Many ways to think about it. (#2)
  + AI agents could help build intuition and reduce the space of all possible modalities to a manageable set. (#3)
  + Interest groups that enable connection and informal get togethers on topics across DOE (#7)
  + Question: How do these technologies foster innovation and team-driven science? (I think they help improve the latter, but can we tie them to innovation?) (#9)
    - They enable collaboration more broadly--right now we collaborate locally because we can see people and this facilitates collaboration somewhat. Overcoming those barriers with some of these technologies could change that paradigm (#12)
  + Question: We talked about improving diversity earlier - do any of these technologies help enable improved diversity? (#18)
  + (2) Discussion: Need a technology that enables collaboration in space (ie remote collaboration) and across disciplines. (#19)
    - Would enable communities that would have impediments to collaboration (e.g. funding constrained in travel $$, family committments, etc) (#20)
    - (1) What are the requirements? The better an internet connection that you have the better interaction. High-bandwidth capabilities and software that facilitates that. The more real you can make it, the more collaborative it feels. (#22)
    - Tools to connect people to disciplines. "Dial an expert" - have a rolodex of individuals who are willing to discuss topics, collaborate, etc. Woudl great if this were an expectation of a scientist. Re-organized LinkedIn (something similar to ResearchGate) (#23)
    - (2) Breaking barrier in collaboration - a technology that identifies repeat collaborations to help bring different groups together and expand their collaboration opportunities. Take a sabbatical from your collaborators. (#24)
      * AI Algorithms to help match collaborators. Look at publishing topics and identify commonalities and potential "matches" (#25)
  + Need to create remote interest groups that enables the ability to meet people. "Coffee-bot" - randomly pairs people who are interested in "randomly" meeting. (#21)
  + (1) Would be nice to do "spontaneous synthesis" - not just do the synthesis based on a recipe, but changes course as need and autonomously. (How does the robot get the chemicals? Does a person give the robot the chemicals, and then leave? What risks are involved - could be more likely to destroy something through a bad reaction). Or could you now create a safe space (e.g. blast box) (#40)
* Who is/will develop this companion technology/service?
  + As with the consensus on what questions are important, the develop of the attendant technologies requires drivers from the constituent communities. These drivers can likely not be effective if they come from what is done for a modern requirements gathering exercise for SW technology. (#6)
  + Industry, but NLs may play a role. For instance Occulus (etc) is one example of how you can coexist and interact in a space. Could that be made even more real? Autonomous instrumentation requires industry to develop, but NLs (and other industry) would play a large role in developing and testing and informing what is needed. (#4)
  + There are tools emerging from industry so the hope is that they continue to evolve in ways that enable collaborative technical spaces that allow serendipity as well as work. (#13)
  + (1) For collaborative technologies, there is a large(r) driver likely coming from industry. The National Labs should focus on those technologies that meet the requirements unique to the national labs (and broader scientific needs). For example, remote experimental capabilities will likely not be as needed from industry. (#14)
  + (3) Discussion: Can a scientist sitting at home still do synthesis by controling a laboratory operation elsewhere? Could improve safety plus foster collaboration. Many collaboration software will come from industry b/c of the broader need. Should focus our efforts on science-driven needs. (#26)
    - Many impediments exist in policy, security, (authentication, authorization), "sociological" barriers that prevent collaboration today via Jupyter notebooks and the sharing of data. Probably going to get worse in the future. We need robust ways to handle authorization and authentication in the future (technologies will improve, but the need will outpace) (#27)
      * (1) Facets of this are unique to the federal sector (privacy concerns that are great) (#28)
    - (1) Collaborative technologies can't be developed through requirements gathering alone. Co-design is required between the developers and end users. (#29)
      * National labs and the federal sector have to drive the last mile (if we use industry-developed technology solutions) (#30)
      * Microscopy vendors are trying to partner with the National Labs. May be a success story that we can point to. (#31)
* What skills/knowledge does the end user require?
  + (1) Computer savvy; willingness to learn and do things a different way (#5)
    - +1 -- goes to the point about irreducible complexity. Practitioners are required to develop some facility with the technology they are using. (#8)
  + Right now the pandemic has forced us to quit expecting everyone to travel to the same place. The need is for more of a sociological change that leads to a behavior change that lasts beyond the pandemic. (#15)
  + In the team-driven environment, we also need people to be willing to talk across disciplines and work to find a "common language" (#16)
  + (2) Discussion: For collaborative technology, the more complicated the task is, the more knowledge that you must have of the tool. (Direct corollary to the experiments - the more complex an experiment, the more you must know about the tool). (#32)
    - Should we expect a unique scientific instrument be "easy to use"? Do we have this expectation of ease of use of collaborative technologies? Or is this more like "Zoom" (where the scientist is a pure user). The pieces that are integral to the scientific question must be understandable by the users. (#33)
    - Some concern over autonomous instrumentation driven by AI - the scientist must understand what it's doing under the hood. (#34)
    - (1) Innovation is only going to come from having deep understanding of all the tools used. (#35)
* What are the training/support requirements?
  + support requirements could be pretty intensive. For real time virtual interaction tools, robust networks that have high bandwidths are essential for it to have value. For autonomous instrumentation, also need good networks for the remote researcher to interact, but also AI/ML to help the instrumentation learn and make decisions. (#10)
  + Documentation will continue to be a key need. No amount of ease-of-use can obviate the need for careful documentation. (#11)
  + Any virtual interaction space needs people who maintain it and "dust the furniture", "pick up the trash", and "build new things". (#17)
  + (2) Discussion: Need good documentation and (potentially) a help desk. May need on-site support personnel, depending on the tasks that the autonomous instrumentation performs (e.g. could be a safety) Some communities may have a culture that requires someone to "go in" if needed. How does that work in a remote collaborative environment. (#36)
    - Emergency control response - what happens if you lose connectivity ? Safety concerns are a very real impediment in a fully remote environment. (#37)
    - Should personnel that support these machines - what knowledge must the personnel have? Just about the technologies or the experimenets behind them? (#38)
    - (1) This fully remote environment may limit inclusivity (as well as improve it). If you live in an area with limited internet bandwidth, you may not be able to be included. (But on the flip side, travel limitations are eliminated). (#39)

1.3 Day 1 Reflections

Participants: 0

**Brainstorm question or instruction:**  
Day 1 Reflections  
This area is for the Moderator to note key discussion points to summarize what was accomplished in Day one. Remember that day one is focused on Identifying a new technology or methodology and identifying the implications and possible consequences of it. The moderator can populate this individually at the end of the day or request input from the group here.



2 Day Two - November 5, 2020

2.1 Breakout 3 - Signposts

Participants: 1

**Brainstorm question or instruction:**  
Breakout 3 - Signposts  
What we are looking for is technology or social trends that would give us clues that we are on the right track. o How would precursor technologies/services be identified? o What are the precursor technologies/services? o Is there a rank order for when specific technologies/services need to be available? o What DOE or Lab policies need to be in place now, in 5 years? o What facilities need to be in place now, in 5 years?



**Sticky points:**

 Top Takeaways (5 points per participant)

* 1. Restructure the entire research enterprise within DOE to be a team-based, long-term research focused area. Eliminate group leads and all the administrative overhead. Every DOE lab researcher is a member of the broader DOE research enterprise. A research leader has an idea, brings together other researchers (which could be distributed across many locations, not labs). Pitches the idea to a science council which approves or denies the idea (5 year term, for up to 2 terms for example). External proposals can be written to augment resources (e.g. students and post-docs). But we remove the overhead b/c lab salaries are covered (as long as you are part of a team?)
  + Comments
  + All indirect support (e.g. administrative assistant, computer assistants, etc) are provided out of a central resource (#2)
  + Promotion opportunities are based on individual records (teamwork, research productivity, etc) (#3)
    - Divorce promotion structure from the scientific structure (#4)
  + Could turn the lab enterprise into highly sought-after positions because of the resources available. (#5)
  + Would require the DOE system to be "federalized" (#6)
  + How do you balance competition (which may spur innovation) vs giving people the freedom to pursue innovative ideas without being constrained b/c of funding limitations (#7)
  + Innovation can be challenged if you're always focused on proposal writing. (#8)
  + In other similar systems, an individual is tenured forever (so if their team shrinks/dissolves, they can be a team of 1). But we could design a system differently. (#9)
    - If you're not part of a team, dead weight could perhaps be dropped from the system. (#10)
  + Expectations of the team should be proportional to the size of the team. ($10M project should deliver value proportional to the budget) (#11)
* 12. Our core structure (lab enterprise) is hindering innovation. Would require a complete restructuring of the enterprise (political and cultural change).
  + Comments
  + Signpost: Overhead could be completely covered. Form a science board. Have a competition for some number of teams where 5 years is covered. (#13)
  + Signpost: Communication between offices at DOE (both Office of Science and applied offices) is changed. (#14)
    - Refocus offices toward capabilities? (#15)
    - Initially, teams are formed around existing structures? But then gradually break down those barriers between the offices. Turn toward capabilities. (#16)
      * Already have some examples: SciDAc, ECP, etc of where we have tried thtis (#17)
    - Need to have more topic conversations ... workshop along capabilities that enable cross-discipline discussions. (#26)
  + Signpost: Rip off the bandaid? Just move to this structure rather than trying to make a slow cultural change. (#18)
    - Start at the top with the lab directors? Eject many of them because they prefer to create an empire. Perhaps the lab enterprise is federalized or lab directors are evaluated by DOE metrics, not by contractor metrics.? (#19)
      * Need to make movement across the enterprise easier. Common benefits (or no penalty moving between labs) (#20)
      * Move to a system where lab contractors aren't there to make $$, but are interested in broader societal good. (#21)
  + Advantage: Would be able to move to new priorities (e.g. national emergencies) without fear of missing existing deliverables. (#22)
  + Advantage: Gives individual buy-in of the DOE institution. Research Time is covered, allowing people to focus on core work. (#23)
  + Advantages: No barriers to being a distributed teams (but also no barriers to the team being entirely co-located) (#24)
    - Signpost: Distributed teams would require technology to network effectively remotely, and collaborate remotely. (#25)
* 27. Signposts that indicate that we have enabled a culture or structure teams
  + Comments
  + Signpost: Cross-lab, cross-discipline teams are forming (#28)
  + Signpost: Culture and expectation changes from one of always seeking funding for survival (vs our expectation that they be a good scientist) (#29)
  + Signpost: Competing complex-wide to get a lab scientist position (#30)
    - Distinction from other similar models: Do not want the silos preventing collaboration. (#31)
    - Question: What do facilities look like in this model? Are they more like this model already? (Except facilities today feel like they are going to continue to exist in the future ...) (#32)
      * Are DOE user facilities the "mecca" for science to happen? (#34)
      * Question: How does NNSA fit into this model? (#33)
  + Signpost: Enterrpise provide enough resources for the scientist and the people "doing the work" (#35)
    - Need to delineate what extra funding is and is not in-bounds. (#36)
    - Need to do a lessons learned on how the labs and other institutions have evolved to where we are today and prevent a similar evolution in the future. (#37)
      * How do we prevent complacency if we still want to maintain innovation. (#38)
      * How do we change how innovation is viewed? Progress may be incremental (in addition to those that are nobel-prize worthy) (#39)
      * Need to redefine metrics. Failure should be okay. (#40)
  + Risk: Lack of competition could lead to complacency. We need signposts to tell us if this is happening. (#41)
    - Signpost: Metrics around publications and other artifacts (e.g. invited talks. patents, etc), community perception (how do you capture that?) to tell us if/when this is happening (#42)

2.2 Breakout 4 - Signpost Plausibility

Participants: 2

**Brainstorm question or instruction:**  
Breakout 4 - Signpost Plausibility  
Now that we have the list of signposts, the groups need to consider how plausible they are and what DOE needs to do to either ensure they happen or the implications of them not happening. o Who is actively working on these precursors? o When would these precursor technologies/services be needed? o What active or pending research programs need to be in place now? In 5 years? 10? o What existing or planned facilities need to be in place now? In 5 years? 10? o What software services or capabilities need to be in place now? In 5 years? 10? o How successful has the community been in meeting previous goals?



**Sticky points:**

 Top Takeaways (5 points per participant)

* 29. Signposts listed below, listed in order that we believe they would be encountered.
* 1. Signpost: Cross-lab, cross-discipline teams are forming
  + Comments
  + and sustaining as a primary scientific endeavor - not a one-off. (#8)
  + This is the first signpost that will be encountered - and could be measured as early as today. But should be continually re-evaluated - e.g. are cross-discipiline teams formed, have we broken the stove-piping across DOE Offices. (#9)
  + The ideas that these teams are working on and the plan is evaluated by a cross-lab team for its merits. (#10)
  + Examples of these sorts of teams exist today but they are one-offs - this sign-post would be that they are becoming more routine (#11)
* 25. Signpost: Early career researchers have opportunities to lead projects teams and get funding.
  + Comments
  + This signpost can occur immediately. Early career researchers should be encouraged to develop their own research ideas, lead teams and have a pathway to being included (or lead) their own endeavors. (#26)
  + Cross-lab collaborations / teams would be barrier free (#30)
* 21. User Facilities continue to exist as they are but the barrier between the user facilities and the project teams is porous and facilities personnel are able to join project teams and vice-a-versa.
  + Comments
  + DOE User Facilities (both computational and experimental) are viewed as a place where world-class science happens. (#28)
  + Project teams are able to easily engage with User Facility scientists. Appropriate person-to-person connections are easily findable. (#31)
* 2. Signpost: Culture and expectation changes from one of always seeking funding for survival (vs our expectation that they be a good scientist)
  + Comments
  + Culture changes to pursuing new projects that are focused on national and DOE priority ideas and gathering teams to pursue those ideas. Proposals are then for the resources needed. (#12)
  + The COVID HPC consortium is an example of the sort of culture we want to be prevalent (#13)
  + People still agressively seek funding for new ideas because they are good ideas (that pass peer review) - not just to keep their job (#14)
* 4. Signpost: Enterrpise provide enough resources for the scientist and the people "doing the work"
  + Comments
  + This includes coving overhead and the facility operation in another way than funding via individual grants (#7)
  + Scientists would continue to propose innovative ideas and research, but the indirect support would be funded by the enterprise (at a level to meet the needs of the research) (#20)
* 15. Signpost: Cross-disciplinary team science is the norm not the exception at the labs and is barrier free.
* 23. Signpost: Industry and other agency collaborations are relatively barrier free.
  + Comments
  + DOE labs should continue to be a place where multi-agency work can happen, and collaborations with industry are possible. (#24)
* 5. Risk: Lack of competition could lead to complacency. We need signposts to tell us if this is happening.
  + Comments
  + Signpost: Metrics around publications and other artifacts (e.g. invited talks. patents, etc), community perception (how do you capture that?) to tell us if/when this is happening (#6)
  + However, working on projects is still very much competitive and if you are not valuable to a team you are not included. Not being on a team likely increases risk of not having a job. (#19)
* 3. Signpost: Competing complex-wide to get a lab scientist position
  + Comments
  + Metric (that may be had to quantify): A lab scientist job is viewed as a prestigious and desired position. (e.g. that of a Max Planck position) (#27)
* 16. Signpost: Movement between labs is barrier free
  + Comments
  + The similarities between the individual labs are greater than their differences (e.g. values) (#17)
  + Benefits, years of service continue and there is no negative implication. People move between labs for many different reasons - family relocation needs, be closer to collaborators, etc (#18)
  + Barriers still exist for weapons and other high security work requiring special certifications. (#22)