Oppenheimer Science and Energy Leadership Program

OSELP Cohort 7
2024 Think Piece Report

AMES National Laboratory
Argonne National Laboratory
Berkeley Lab
Brookhaven National Laboratory
Fermilab
INL Idaho National Laboratory
Jefferson Lab Thomas Jefferson National Accelerator Facility
Los Alamos National Laboratory
Lawrence Livermore National Laboratory
NETL National Energy Technology Laboratory
NREL National Renewable Energy Laboratory
Oak Ridge National Laboratory
Pacific Northwest National Laboratory
PPPL Princeton Plasma Physics Laboratory
Sandia National Laboratories
SLAC National Accelerator Laboratory
SRNL

About the Oppenheimer Science and Energy Leadership Program

OSELP is the premier leadership development program of the ***National Laboratory Directors' Council****. The program exposes emerging leaders to the singular breadth, diversity, and complexity of the National Labs and their partners in government, industry, and academia.*

This report and Think Pieces from prior OSELP cohorts are available on the ***Oppenheimer Leadership Network*** *(OLN) website at oln.energy. Capstone presentations for select Think Pieces are available here. The OLN is a self-organized alumni association of past Oppenheimer program fellows and other invited members.*

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Special thanks to Marcey Hoover, OSELP Senior Advisor, and Sue Suh, OSELP Mentor, for the exceptional support they provided Cohort 7 in developing this Think Piece report.

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- **Christopher Tassone**, SLAC National Accelerator Laboratory
- **Jolante Van Wijk**, Los Alamos National Laboratory
- **Christina Wildfire**, National Energy Technology Laboratory
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Foreword 2024 Think Piece Report

Leadership is a journey. Over the past year, thirty-one extraordinary leaders from across the laboratory complex first met each other as separate individuals—and they now come away as a team, together.

These members of OSELP Cohort Seven represent multiple countries, multi-sector career paths, a broad range of backgrounds and talents and expertise, and all seventeen national labs. While the Fellows vary in lived experience, they are united in their dedication to the national lab complex, their belief in each other, and what the labs can do together to move humanity forward.

In this spirit, the themes of collaboration and connection are woven through the ideas, learnings and observations you will find in the following pages. We begin with a celebration of the national labs' collective history. Big breakthroughs fuel our imagination and our ambition, and looking back at lab accomplishments provides an inspiring springboard for looking to the future.

We then move to concrete examples of how innovation can come to life—in both existing ways and new. What kinds of shared infrastructure might help the national labs? How much more societal benefit could be unlocked by increased tech maturation and transfer? Could an LDRD program across all seventeen labs serve to solve grand challenges? And can we imagine how artificial intelligence could support all of the labs working together in pursuit of a world-changing scientific discovery?

The Fellows then bring it home with an essential spotlight on people and culture, which underpins everything the labs do: strengthening lab staff and communities by increasing and nurturing diversity; comprehensively equipping front-line leaders to guide the way through rapidly evolving global priorities; and reflecting on OSELP itself as a unique leadership development experience that continues to grow in impact and potential.

Our think piece report may introduce new perspectives, as well as cover topics familiar to senior leadership throughout the complex—either from previous years' think pieces or from your own day to day urgencies, hopes and goals. This combination of "new" and "renewed" topic areas is intentional, based on the cohort's energized observations and what they learned from each of you in their year-long journey.

We're so proud of this cohort and have no doubt they will continue changing the world. Thank you for your support and inspiration throughout this year.

The OSELP Team—Kevin Doran, Sue Winters, Marcey Hoover, and Sue Suh

Members of Cohort 7 at Oak Ridge National Laboratory, January 2024

Front row (left to right): Ning Kang, INL; Matthew Myrick, LLNL; Ronald Boring, INL; Susan Winters, OSELP Deputy Director; Christina Wildfire, NETL; Katrin Heitmann, ANL; Ami Dave, FNAL; Roderick Jackson, NREL; Pia Wilson, PPPL; Jim Serafin, ORNL; Chris Tassone, SLAC; Kevin Doran, OSELP Director. Second row (left to right): Jolante Van Wijk, LANL; Kane Fisher, LANL; Teresa Daniels, BNL; Eileen Crowley, FNAL; Katy Christiansen, LBNL; Kirstin Alberi, NREL; Amanda Schoch, PNNL; Kaila Raby, SNL; Carol Meyers, LLNL; Lindsay Brown, SRNL; Michael Spata, TJNAF; Luisella Lari, BNL. Third row (left to right): Douglas Higinbotham, TJNAF; Joe Cruz, PNNL; John Stevens, ANL; Michael Descour, SNL; David Micheletti, PPPL; Arianna Gleason, SLAC; Yarom Polsky, ORNL; Ikenna Nlebedim, Ames; Donald Ferguson, NETL.

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EXECUTIVE SUMMARY

DOE National Laboratories Collective History

Authors: Carol Meyers (LLNL), Ami Dave (FNAL), Ronald Boring (INL), Lindsay Brown (SRNL), Katy Christiansen (LBNL), Teresa Daniels (BNL), Arianna Gleason-Holbrook (SLAC), Douglas Higinbotham (TJNAF), Matthew Myrick (LLNL), Ikenna Nlebedim (Ames), Michael Spata (TJNAF), Amanda Schoch (PNNL)

The Department of Energy (DOE) national laboratory system contains 17 labs and has housed over 70 Nobel prize-winning scientists. National lab scientific breakthroughs have led to the discovery of new elements, catalyzed the computer age, uncovered the building blocks of matter, and pushed the frontiers of fusion energy.

This Think Piece celebrates the rich collective history and accomplishments of the national laboratories as a system, via an online interactive timeline. The timeline traces the evolution of the laboratory system over time and the scientific breakthroughs, innovative technologies, and world-class facilities as they arose in support of these missions.

Though there are many resources detailing accomplishments and facilities at individual labs, there are far fewer resources on the collective history of the national laboratory enterprise. In addition, as demographics shift and a new generation enters the lab complex, the stories of the research, achievements, and movements that built these institutions risk fading. Our effort aims to fill this gap by helping new and current lab employees understand the vast history of which they are a part, as well as educating the public on the national laboratory system and its contributions to our lives, our national security, and the body of science.

The interactive timeline is located at following URL. The timeline is password-protected until the NLDC approves sharing of timeline with the general public.

https://www.tiki-toki.com/timeline/entry/2083284/The-DOE-National-Laboratory-System/

DOE National Labs—Infrastructure Challenges & Opportunities

Authors: Lindsay Brown (SRNL), Eileen Crowley (FNAL), Joe Cruz (PNNL), Teresa Daniels (BNL), Ami Dave (FNAL), Dave Micheletti (PPPL), Jim Serafin (ORNL), Pia Wilson (PPPL)

National Labs rely heavily on key supporting functions, such as infrastructure and operations, to fulfill their mission commitments. These functions must operate in a manner that is safe, compliant, efficient, reliable, and sustainable. Through our engagement with Cohort 7, we have come to appreciate that while each lab is unique in its mission, methods, and culture, they face similar challenges and opportunities. This think piece aims to identify common infrastructure and operations challenges across the labs for potential further study by the Oppenheimer Leadership Network or other relevant working groups. Our group explored the following concepts:

- **Sustainably and reliably meeting the growing demand for electrical power**: Assessing the various strategies employed by labs and exploring opportunities for collaboration.
- **The hidden costs of Line-Item projects**: Understanding the additional expenses often associated with line items to better prepare for future projects.
- **Science Accelerating Girls' Engagement (SAGE) for Trades concept**: Developing the SAGE program to create a pathway and pipeline for diverse candidates in trades that support our science mission.
- **Reducing cycle time for key infrastructure projects**: Optimizing procurement practices and utilizing repeatable designs and specifications.
- **Secure infrastructure**: Leveraging the benefits of these capabilities to increase the impact on our missions.

While the team viewed each topic as worthy of further exploration, we elected to focus on secure infrastructure, including the acquisition, sustainment, and use of Sensitive Compartmented Information Facilities (SCIFs). The acquisition of a SCIF must be approved by the DOE Office of Intelligence and Counterintelligence (DOE-IN), a process that can be protracted. Additionally, the cost to establish a SCIF within an existing building can be substantial—$1,200+ per square foot is not uncommon. Once constructed, the SCIF must be certified by an approved authority; and once established, SCIF space is expensive to operate and maintain. Standards frequently change, necessitating upgrades which are often unfunded. The modification/recertification process can result in significant loss of use and therefore mission impacts.

We suggest that the National Labs create Regional National Security Centers. This offers the laboratories an opportunity to pool resources and capitalize on expertise from labs without SCIF space for national security work. Establishing Regional National Security Centers makes it more cost-effective to establish a SCIF closer to the talent pools we need—boosting recruitment and retention efforts and allow the workforce from laboratories without onsite SCIF space to contribute. They also provide resilience and capacity (e.g., when a SCIF is unavailable).

Opportunities for Enhancing Technology Maturation and Transfer at the National Labs

Authors: Kirstin Alberi (NREL), Ron Boring (INL), Arianna Gleason (SLAC), Ikenna Nlebedim (Ames), Mike Spata (TJNAF), Christina Wildfire (NETL)

The National Laboratories are instrumental in advancing the Department of Energy's (DOE) missions in national security, energy infrastructure, and scientific research. A significant challenge, however, is ensuring that the groundbreaking work conducted by these labs reaches end users—whether they are private sector companies, the U.S. weapons stockpile, unique scientific facilities, or other applications. Many innovative ideas and emerging technologies stall at various "valleys of death" within the technology maturation pipeline, partly due to insufficient resources and programs to overcome these barriers. Strengthening mechanisms for technology maturation and placing renewed emphasis on related activities across the labs could substantially amplify their impact on DOE's missions and the broader U.S. economy.

Inspired by tours of the National Labs and discussions with their leadership teams, OSELP Cohort 7 envisioned strategies to enhance the maturation of lab-developed technologies. Although a complex ecosystem of policies, regulations, incentives, and relationships with DOE offices limits the labs' ability to independently implement improvements, our experiences suggest that the labs can initiate steps toward enhancing technology maturation.

Throughout our learning journey, we encountered numerous insightful and creative ideas for advancing technology maturation. A key theme is the need to adjust mindsets to foster greater innovation. Encouraging, incentivizing, and training researchers to consider end users during early-stage technology development can reduce barriers when advancing technologies up the readiness scale. Sharing best practices and programs between labs is another vital strategy. Many labs have individually developed effective programs and tools; sharing these and forming joint initiatives would more effectively leverage existing knowledge and infrastructure.

Collective advocacy emerged as a critical approach, as the greatest challenges—and potential impacts—stem from DOE-enacted policies. Using a unified voice to collaborate with DOE may be the most promising route to effect targeted and beneficial changes. Adjusting existing program scopes and structures in partnership with DOE, as well as creating new programs, could reduce current barriers and fill gaps in the research and development ecosystem.

Regularly seeking input from external reviewers and acting on their recommendations is essential in the evolving landscape in which the National Labs operate. This practice can help identify blind spots or opportunities to refine programs further, ensuring agility in approaches to innovation and technology maturation. Additionally, encouraging "big swings"—taking calculated risks—can be instrumental. Collaborating with each other and DOE to assess and accept certain risks is an important step toward increasing the success rate of the labs' technology maturation efforts.

Our Learning Journey into the Laboratory Directed Research & Development (LDRD) Program

Authors: Eileen Crowley (FNAL), Michael Descour (SNL), Douglas Higinbotham (TJNAF), Ikenna Nlebedim (Ames)

The Laboratory Directed Research & Development (LDRD) program was authorized by Congress in 1991 and updated in 2020 to include the one government-owned government-operated (GOGO) laboratory. The LDRD program creates a unique way for the 17 national laboratories to support innovative and cutting-edge projects to ensure the complex stays at the forefront of science and technology. In the spirit of learning more about this impactful program, our part of the Oppenheimer Science and Energy Leadership Program (OSELP) cohort explored how LDRD projects and programs are judged for success, both by the Department of Energy (DOE) and by the individual laboratories and to understand the possibilities of "grand" LDRD projects, i.e., something in the spirit of the Manhattan Project, in which all the laboratories put their unique skills together to solve technological challenges. The "LDRD Manhattan Project" idea builds on the multi-laboratory LDRD vision proposed by OSELP Cohort 5 and we include relevant lessons learned thus far. As the multi-laboratory LDRD program has started to form, first with the three National Nuclear Security Administration (NNSA) laboratories, and now with some of the other larger laboratories, we also explored how the laboratories with comparatively much smaller budgets can get involved. Each of the 17 laboratories has unique capabilities and expertise to contribute to further the breadth and impact of interlaboratory LDRD projects.

AI for Science: Shaping the Future of the National Lab Complex

This Think Piece is dedicated to Charlie McMillan, former LANL Laboratory Director and OSELP Mentor, who inspired us during our Los Alamos visit to work on this topic. He is deeply missed.

Authors: Katrin Heitmann (ANL), Don Ferguson (NETL), Jolante van Wijk (LANL), Luisella Lari (BNL), Mike Spata (TJNAF), Christopher Tassone (SLAC)

Rapid advancements in Artificial Intelligence (AI) technologies have sparked an industrial race for technological supremacy, presenting both opportunities and challenges for the national laboratory complex. With the accelerating pace of AI development, it is imperative for the national labs to refine their strategies to avoid obsolescence in discussions about AI's role in scientific progress. This Think Piece examines how AI may shape the national laboratory complex over the next five years. Informed by a multi-laboratory survey, lab visits, and input from stakeholders across the labs, it highlights both opportunities and challenges. We propose a *Gedankenexperiment*—a "Data Challenge Case Study"—to unite domain and computer scientists in curating data from multiple national labs.

Key Findings

- **AI Impact on Research**: AI is expected to automate routine tasks, enhance scientific discovery, and evolve into sophisticated assistants, although significant challenges remain in leadership, funding, and specialized datasets.
- **Workforce Transformation**: While some roles may diminish due to automation, new opportunities will arise in AI development, necessitating upskilling and reskilling of the current workforce to leverage AI effectively.
- **Collaboration Models**: A unified vision and strong leadership are critical to overcoming internal competition and developing innovative collaboration models with other government agencies, academia and industry, focusing on long-term goals.
- **Data Sharing Challenges**: Issues around data ownership, data curation, cybersecurity, and cultural resistance impede data sharing. A comprehensive strategy for standardizing data formats and promoting openness is required.
- **Ethical Guidelines for AI**: Establishing best practices for the ethical use of AI is crucial to ensure trust and accountability, mitigate bias, and safeguard sensitive data.

Conclusion

Integrating AI into the national laboratories presents a transformative opportunity for scientific progress and national security. Success will require strategic planning, strong leadership, ethical oversight, and a collaborative culture. By addressing existing barriers and embracing AI responsibly, national labs can harness its potential for advancing science and benefiting society. The authors advocate for a coordinated approach that enhances flexibility, investment in AI expertise, and improved data management to fully realize AI's advantages.

Our OSELP Learning Journey about Diversity, Equity, Inclusion, and Accessibility at the National Laboratories

Authors: Katy Christiansen (LBNL), Teresa Daniels (BNL), Kane Fisher (LANL), Arianna Gleason (SLAC), Roderick Jackson (NREL), Ning Kang (INL), John Stevens (ANL)

Accomplishment of DEIA goals is crucial for our national laboratories to remain premier institutions for innovation and impact, since we must have the best talent assembled into effective teams. DEIA programs include various activities, from one-time events to ongoing commitments, and must be meaningful to advance the organization's objectives while responding to the distinct character and culture of each laboratory. Understanding and tracking the desired outcomes of DEIA programs is essential to achieving success.

Desired outcomes of DEIA programs include:

- Recruitment of the best available talent from the breadth of the US population
- Enhanced job satisfaction and increased engagement
- Skill development among employees
- Improved retention rates
- Career advancement for employees
- Development of a diverse leadership pipeline
- A more inclusive organizational culture that fosters highly effective teams

However, external factors such as government policies and regulations, organizational changes, and funding availability can impact DEIA programs. When DEIA initiatives are prohibited, these outcomes can still be achieved through universal programs that focus on recruitment, belonging and career advancement. By evaluating programs on a regular basis, desired outcomes can be measured and approaches can be aligned to achieve success.

By refocusing DEIA programs and developing alternative approaches, National Laboratories can ensure that they are promoting excellence and innovation in their workforce while aligning with evolving constraints.

Enabling a Vibrant Management and Leadership Culture Across the National Lab Complex

Authors: Christina Wildfire (NETL), Kaila Raby (SNL), Yarom Polsky (ORNL), David Micheletti (PPPL), Christopher Tassone (SLAC), Jim Serafin (ORNL)

The Think Piece explores fostering a vibrant leadership culture across the national laboratory complex to address challenges and leverage opportunities arising from workforce transitions. With over 50% of staff at many labs being new in the last five years, the authors identify key areas to strengthen leadership at all levels, particularly among first-line managers, who play a critical role in aligning teams with institutional goals and culture.

Key Findings

1. **Survey Insights**: A survey of the OSELP Leadership Network (OLN) highlighted gaps in managerial training, time allocation for staff engagement, and clarity in roles and responsibilities. Key issues include: insufficient time for managerial duties; undefined managerial roles; initial unpreparedness for management roles; and lack of defined professional development strategies.
2. **Leadership vs. Management**: The piece differentiates management (oversight and compliance) from leadership (direction-setting, engagement, and cultural influence). While compliance training is robust, leadership development efforts vary significantly across labs.
3. **Best Practices in Leadership Development**: Based on survey data and interviews with HR staff, the authors identified effective strategies, such as forming peer support cohorts, making leadership training mandatory, and integrating coaching and simulation-based learning. These approaches ensure managers are equipped for their roles and can foster a supportive, high-performing culture.
4. **Role Clarity and Time Allocation**: Clearly defined responsibilities and dedicated time for staff engagement are critical to managerial effectiveness. Labs with unclear expectations risk overburdening managers, leading to burnout and disengagement.

Inspirational Findings: Several labs are pioneering innovative leadership initiatives, including:

- Cross-functional peer networks.
- Tailored leadership programs.
- Consistent accountability frameworks tied to performance metrics.

Conclusion

Front-line leaders are pivotal in shaping a healthy, mission-aligned culture. While challenges remain, there is optimism due to the promising leadership programs being rolled out across the lab complex. The authors encourage collaboration and knowledge-sharing to accelerate progress in leadership development across all labs.

EXECUTIVE SUMMARY

OSELP Itself: Reflections on Impact, Effectiveness and Potential

Authors: Lindsay Brown (SRNL), Donald Ferguson (NETL), David Micheletti (PPPL), Christopher Tassone (SLAC), Christina Wildfire (NETL)

The Oppenheimer Science and Energy Leadership Program (OSELP) distinguishes itself within the Department of Energy (DOE) National Laboratory complex as a unique leadership development initiative. Unlike other programs, OSELP spans all 17 national labs, offering a comprehensive perspective on the DOE ecosystem through year-long experiential learning, site visits, and in-depth engagement with senior leadership.
A survey of alumni and current participants highlighted the program's distinctive strengths:

2. **Direct Exposure to Labs and Leaders**: Participants gain unparalleled access to lab operations and challenges through hands-on site visits and candid discussions with senior leaders.
3. **System-wide Perspective**: OSELP emphasizes understanding the broader DOE complex, fostering a strategic mindset and systemic problem-solving abilities.
4. **Extended Engagement and Networking**: The year-long format and focus on relationship-building create a resilient professional network and trust among cohort members.
5. **Holistic Leadership Context**: Participants appreciate the integration of real-world leadership challenges, diverse lab cultures, and DOE's mission-focused operations.

Survey results reveal that 90% of alumni utilized OSELP knowledge and networks to positively impact their home institutions, with significant career progression for many participants. Alumni also expressed interest in enhancing program impact through structured knowledge-sharing and mentorship opportunities.

Proposed Enhancements

- **Local Leadership Development Programs**: Create internal initiatives modeled on OSELP to address early-to-mid-career development needs.
- **Structured Knowledge Dissemination**: Introduce mandatory seminars for fellows to share insights with home institutions.
- **Alumni Mentorship**: Formalize mentorship roles to support current fellows and strengthen local leadership networks.

By cultivating a deep understanding of the DOE ecosystem and fostering cross-laboratory collaboration, OSELP equips leaders to address national challenges. The proposed enhancements aim to amplify the program's benefits, ensuring lasting impacts for participants and the DOE community.

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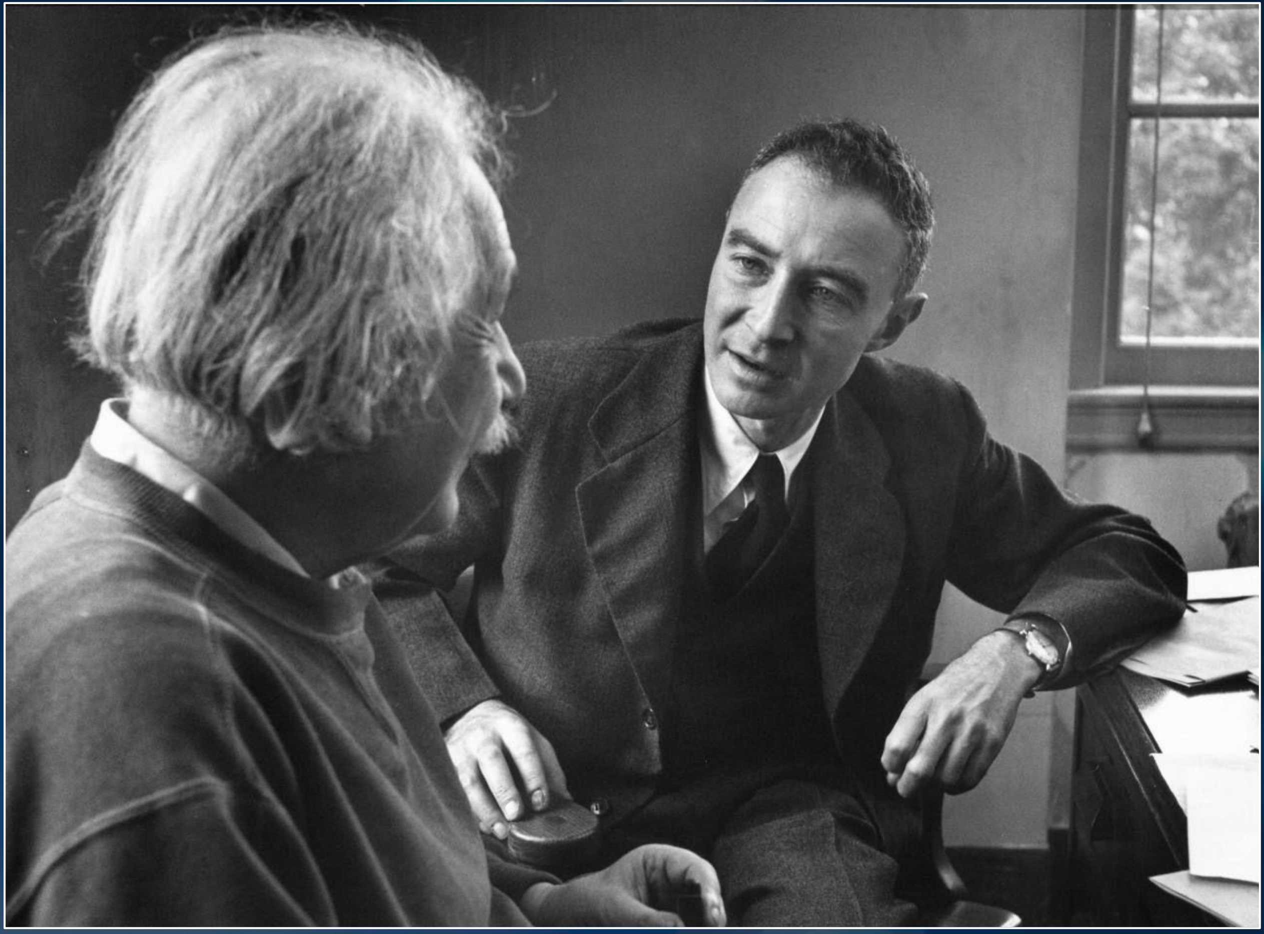

DOE National Laboratories Collective History

Authors: Carol Meyers (LLNL), Ami Dave (FNAL), Ronald Boring (INL), Lindsay Brown (SRNL), Katy Christiansen (LBNL), Teresa Daniels (BNL), Arianna Gleason-Holbrook (SLAC), Douglas Higinbotham (TJNAF), Matthew Myrick (LLNL), Ikenna Nlebedim (Ames), Michael Spata (TJNAF), Amanda Schoch (PNNL)

Overview and Purpose

The Department of Energy (DOE) national laboratory system contains 17 labs and has housed over 70 Nobel prize-winning scientists. National lab scientific breakthroughs have led to the discovery of new elements, catalyzed the computer age, uncovered the building blocks of matter, and pushed the frontiers of fusion energy. National lab technologies are widespread in our lives, in areas including medical diagnostics, airport security, batteries, lighting, DVDs, and wind, solar, nuclear, and coal-fired power generation. National lab facilities encompass unique world-class capabilities and equipment, used by the broader scientific community to extend the limits of possibility.

This past year, we have had the opportunity to explore the rich tapestry of history within the national lab system. During visits to these labs, historians and passionate enthusiasts shared stories of the labs' origins, triumphs, and transformative discoveries. It became clear that even those who have dedicated their careers to the lab system often remain unaware of its intricate past—a past that shaped not only scientific innovation but the very fabric of modern technological advancement.

This Think Piece celebrates the rich collective history and accomplishments of the national laboratories as a system, via an online interactive timeline. The timeline traces the evolution of the laboratory system over time and the scientific breakthroughs, innovative technologies, and world-class facilities as they arose in support of these missions.

Though there are many resources detailing accomplishments and facilities at individual labs, there are far fewer resources on the collective history of the national laboratory enterprise. In addition, as demographics shift and a new generation enters the lab complex, the stories of the research, achievements, and movements that built these institutions risk fading: the next wave of scientists and innovators are stepping into a system with only fragments of its past in their grasp. Our effort aims to fill this gap by helping new and current lab employees understand the vast history of which they are a part, as well as educating the public on the national laboratory system and its contributions to our lives, our national security, and the body of science.

Interactive Timeline

The interactive timeline is located at following URL.

https://www.tiki-toki.com/timeline/entry/2083284/The-DOE-National-Laboratory-System/

As depicted in Figure 1, the timeline contains four “swimlanes”: (1) the National Laboratories; (2) Scientific Breakthroughs; (3) Innovative Technologies; and (4) World-Class Facilities, as indicated in the upper left. The timeline background (overlaid) details the evolution of the lab system and its “owners” (ending with DOE).

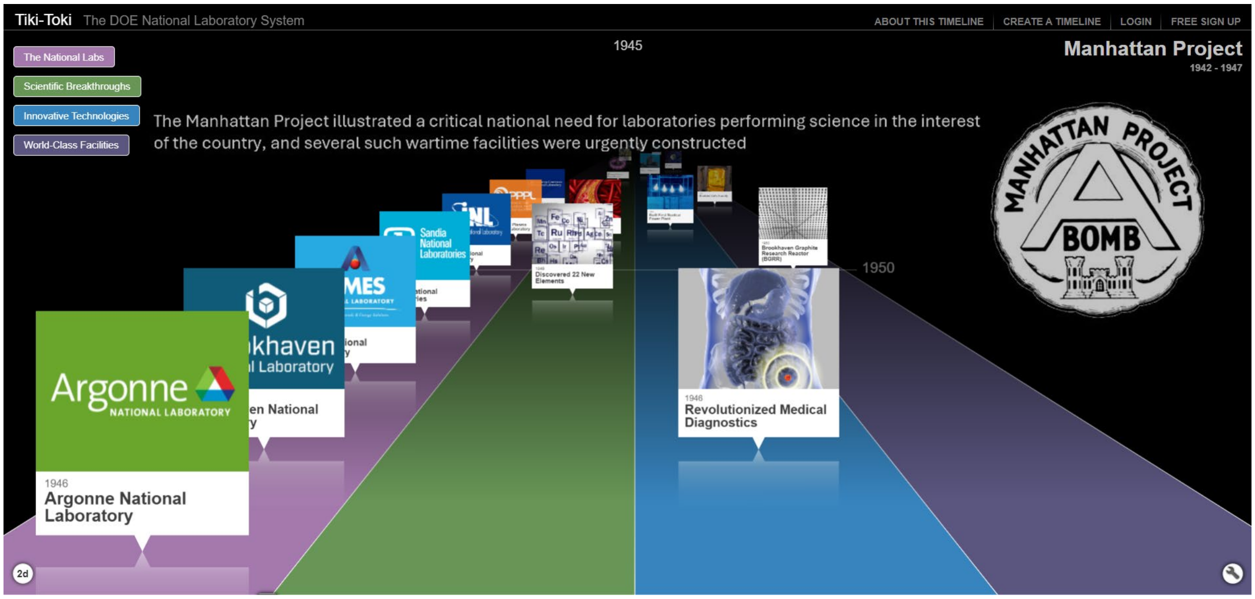

***Figure 1**: A screenshot from the timeline showing the four swimlanes.*

On the timeline, users can select items to learn about that laboratory, achievement, or facility (Figure 2). The timeline is 3D by default and can be toggled to 2D via the icon in the lower left. The search function in the lower right allows users to filter items by laboratory or keyword.

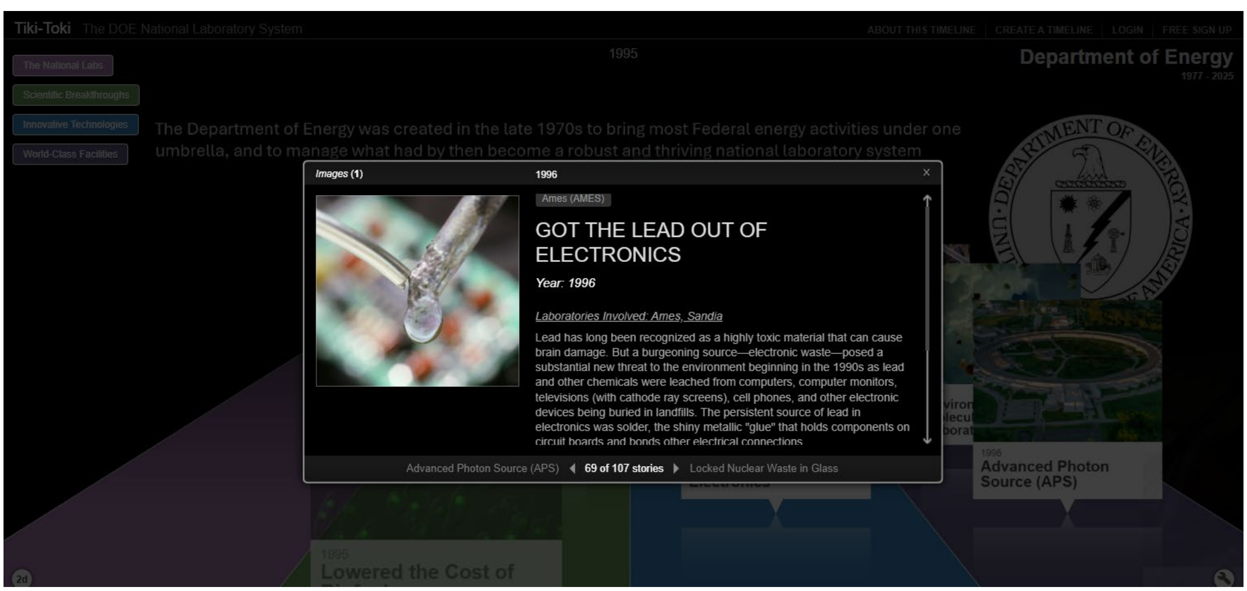

***Figure 2**: An interactive informational feature for Ames National Laboratory.*

Process

The timeline content is populated by information from public domain national laboratory and DOE websites. The information used in the timeline's swimlanes is from the following sources:

- **National Laboratories**: Verbiage is largely taken from Annual Report on the State of the DOE National Laboratories, https://www.energy.gov/articles/state-doe-national-laboratories-2020-edition.
- **Scientific Breakthroughs and Innovative Technologies**: Items are almost entirely taken from 75 Breakthroughs by America's National Laboratories, https://www.energy.gov/articles/75-breakthroughs-americas-national-laboratories-0. Verbiage and pictures are from national lab or DOE websites on the accomplishments.
- **World-Class Facilities**: Items were taken from national lab websites and/or the website of DOE Office of Science User Facilities (https://science.osti.gov/User-Facilities). Several facilities are reflective of those housing current Oppenheimer program participants.

The timeline background (overlaid content) contains one entry for each "owner" of the national lab system (ending with DOE). The verbiage is largely based on content in *The National Labs: Science in an American System*, 1947-1974, by Peter Westwick.

In building the timeline, we consulted with DOE historian Eric Boyle, who offered his blessing and advice, and Los Alamos site historian Nic Lewis, whose own timeline inspired us to use the Tiki-Toki platform: https://www.tiki-toki.com/timeline/entry/1072961/History-of-LANL-Computing/.

We met with the National Laboratory Chief Communications Officers (NLCCO) for their expertise and are indebted to one of our team members who is the chief communications officer at PNNL. Finally, we met with several site historians and archivists, including Nic Lewis (Los Alamos), Rebecca Ullrich (Sandia), and Valerie Higgins (Fermilab) for their historical perspective.

Future Impact and Legacy

The DOE National Laboratory timeline is a significant contribution toward sharing the collective achievements of these vital American institutions. While future updates may enhance its utility, it is relevant to note that as it stands, the timeline captures decades of groundbreaking scientific discoveries, technological innovations, and world-class facilities that have shaped our nation: historical context that will remain relevant for years to come. The breakthrough discoveries, from the earliest days of the Manhattan Project to recent advances in quantum computing and clean energy, tell a compelling story of American scientific leadership and innovation.

Looking ahead, there are natural stewardship opportunities through either the National Laboratory Directors' Council (NLDC) or the DOE Historian, in partnership with the NLDC and NLCCO Working Group. These paths could provide frameworks for future updates; however, the timeline's underlying value as a historical resource exists independent of such updates.

DOE National Labs—Infrastructure Challenges & Opportunities

Authors: Lindsay Brown (SRNL), Eileen Crowley (FNAL), Joe Cruz (PNNL), Teresa Daniels (BNL), Ami Dave (FNAL), Dave Micheletti (PPPL), Jim Serafin (ORNL), Pia Wilson (PPPL)

Overview

National Labs rely heavily on key supporting functions, such as infrastructure and operations, to fulfill their mission commitments. These functions must operate in a manner that is safe, compliant, efficient, reliable, and sustainable. Through our engagement with Cohort 7, we have come to appreciate that while each lab is unique in its mission, methods, and culture, they face similar challenges and opportunities. The team narrowed its focus toward five concepts summarized below:

- **Sustainably and reliably meeting the growing demand for electrical power**: Assessing the various strategies employed by labs and exploring opportunities for collaboration.
- **The hidden costs of Line-Item projects**: Understanding the additional expenses often associated with line items to better prepare for future projects.
- **Science Accelerating Girls' Engagement (SAGE) for Trades concept**: Developing the SAGE program to create a pathway and pipeline for diverse candidates in trades that support our science mission.
- **Reducing cycle time for key infrastructure projects**: Optimizing procurement practices and utilizing repeatable designs and specifications.
- **Secure infrastructure**: Leveraging the benefits of these capabilities to increase the impact on our missions.

While the team viewed each topic as worthy of further exploration, we elected to focus on secure infrastructure, including the acquisition, sustainment, and use of Sensitive Compartmented Information Facilities (SCIFs).

Process

We engaged with the Field Intelligence Element (FIE) Directors at all laboratories and sites that operate SCIFs, the Director of Security and the FIE Enterprise Director at DOE-IN, and senior leaders at several laboratories to inform our think piece.

Challenge

DOE’s missions demand the best talent be deployed towards national security challenges within the Intelligence Community (IC). Obtaining security clearances is a time-consuming process, but once a clearance is obtained staff need a secure space to work. These missions will benefit from the full depth and breadth the national laboratory complex has to offer, and more. Our recruitment efforts are hampered when the talent pools we are targeting exist far from the secure facilities the staff needed to do their work.

A SCIF is a highly secured area that is designed for the purpose of storing, handling, and processing sensitive compartmented information (SCI). SCI is a category of classified information that is derived from sensitive intelligence sources, methods, or analytical processes and requires special safeguards to protect the information from unauthorized access. SCIFs are constructed with these safeguards in mind and must be built in accordance with intelligence community directives (ICDs) set by the Director of National Intelligence. ICD-705, Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities, describes both physical and technical specifications and standards as well as best practices for SCIFs. These directives describe physical security measures, electronic surveillance countermeasures, and soundproofing to protect against eavesdropping or interception. An example of the specific construction techniques is shown in Figure 1.

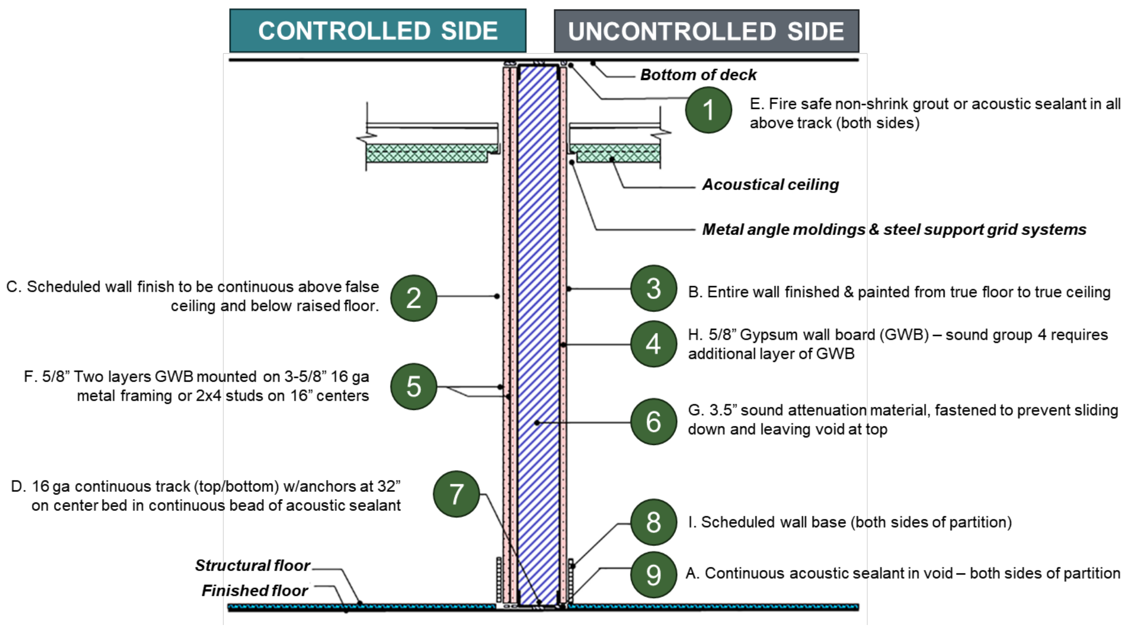

Figure 1: Example SCIF construction techniques.

SCIFs are important because they allow our national laboratories to contribute to critical national security missions within the IC. The IC relies on DOE national laboratories to employ their technical expertise to contribute to key intelligence questions. DOE-IN has established FIEs at several of the DOE laboratories and sites to manage SCI programs and SCIF operations. FIEs and SCIF spaces are in place or being planned at 10 of the 17 labs. DOE-IN approved two of these laboratories to join the FIE enterprise within the last two years, highlighting a growing demand for laboratory subject matter experts to contribute to intelligence work.

One challenge with participating in this mission set is that the process to design, construct, and accredit a SCIF is complex and expensive. The acquisition of a DOE SCIF must be approved by DOE-IN, a process that can be protracted. There must be a FIE in place to operate and manage the facility. The cost to establish a SCIF to meet the ICD-705 requirements can be substantial—$1,200+ per square foot is not uncommon. Once constructed, the SCIF must be accredited by

DOE-IN. Furthermore, once a SCIF is established, it is expensive to operate and maintain. Standards can change, necessitating upgrades, which are often unfunded. The modification/recertification process can result in significant loss of use and mission impacts.

A variety of different funding models are used across the laboratories including:

- **Direct**: Sponsor covers the cost of the facility
- **User pays**: Typically a service center model where costs are recovered through an hourly adder applied to business lines/projects
- **Indirect**: Laboratory overhead funds pay to maintain the facility

Each of these models offer advantages and disadvantages as shown in Table 1.

Table 1: SCIF Funding Model Comparison

Funding Model	Advantages	Disadvantages
Direct	• Clear alignment to sponsor mission and ownership—and funding support • No impact to laboratory overhead • Simple	• May limit opportunities for other sponsors or programs • Potential loss of sponsor funding
User Pays	• Cost is shared proportionally by the benefitting projects	• Funding variability can create challenges if recovery is lower than cost • Less sponsor "equity" in the capability • Complexity associated with cost recovery
Indirect	• Simple • Most flexibility in use	• Cost is fully borne by indirect—for both maintenance and upgrades

Opportunity

We recommend the national laboratories create shared SCIFs called "Regional National Security Centers." Key characteristics include:

- Used by one or more laboratories working under a written agreement
- Located where there are concentrations of talent and/or sponsor demand
- Shared funding model for participating laboratories and programs

The two options are compared and contrasted in Table 2.

Table 2: Shared vs. Single Laboratory SCIFs Comparison and Contrast

	Shared SCIF	Single Laboratory SCIF
Talent	• Opportunity to co-locate with desired talent pools at lower cost	• Can locate with desired talent pools, but the full cost is borne by the owner

	• Should translate into improved recruitment and retention	
Cost (initial and ongoing)	• Shared initial, ongoing & upgrade cost • Need to develop a fair/equitable cost share	• Full cost borne by owner • Simplest to administrate recovery (e.g., within a single laboratory)
Operations	• Need to establish clear R2A2s • How to develop consistent onboarding of staff who use multiple SCIFs • Need to develop approach to issue & event management	• Clear link to FIE Director and laboratory • Simplest issue & event management
Sponsor	• May be difficult to find a single sponsor willing to help others • Greater opportunity for collaboration within the SCIF	• Direct sponsor engagement • Collaboration largely limited to single laboratory

Regional National Security Centers offer our sponsors and the laboratories an opportunity to pool resources and capitalize on expertise from labs without SCIF space for national security work. Further, it presents an opportunity to establish a SCIF closer to the talent pools we need—boosting recruitment and retention efforts. These facilities provide resilience and capacity (e.g., when a SCIF is unavailable). Lastly, they offer the opportunity to gain all of these benefits with lower cost.

We note several considerations should be included in future work:

- Obtaining DOE-IN approval: How to structure the request? Who leads it?
- Security operations:
  - How to consistently onboard/train staff using multiple SCIFs
  - How to manage ownership of events
- Funding model: Address both acquisition and sustainment

In closing, our team has observed several initiatives and models already underway and could be used to further the concept of Regional National Security Centers. DOE-IN is in the process of establishing a SCIF working group to tackle challenges surrounding SCIF construction. This concept could be further developed within this team. Some laboratories have SCIFs located at sites not on laboratory property that they allow other organizations to use. This operational construct could be used as a model for how a regional center might operate. In advancing this concept, the laboratories could also engage with other IC entities to partner on such an effort.

Opportunities for Enhancing Technology Maturation and Transfer at the National Labs

Authors: Kirstin Alberi (NREL), Ron Boring (INL), Arianna Gleason (SLAC), Ikenna Nlebedim (Ames), Mike Spata (TJNAF), Christina Wildfire (NETL)

> *"Aligning the role of the National Laboratories as a strategic partner in end-to-end innovation will require new actions at all levels of the National Laboratory enterprise. These actions span from the level of the individual researchers, through laboratory managers and senior laboratory leadership, laboratory management and operating (M&O) contractors, to ultimately the level of the strategic interface with DOE leadership."*
>
> — EFI, Transforming the Energy Innovation Enterprise Report[1]

Overview

The National Labs entered this decade with important challenges on the horizon, including new national security threats and an urgent need to shepherd the transition to clean and sustainable energy technologies. The labs were purpose built for these grand challenges. The science and technologies we have delivered in past eras of need shaped the trajectory of the world, and we have the potential to do so again. Today, the Department of Energy (DOE) invests billions of dollars[2] in a wide array of basic and applied research and development (R&D) at the labs. A critical objective of this investment is the development of technologies that ultimately reach end users in our security, clean energy, and science missions.

We in OSELP Cohort 7 are proud to be a part of these missions. Our Think Piece identifies how we could work together to enhance technology maturation at the labs in support of them. It was inspired by our remarkable OSELP experience and the overwhelming message we heard across the labs: we are here to make an *impact*.

Why Technology Maturation?

The topic of enhancing the labs' focus on technology maturation and transfer was selected by this working group based on the strong sense of importance and engagement each member has with it at their own lab. Our OSELP in-person lab visits exposed us to new approaches, programs, and concepts for technology maturation, which inspired this group to envision how the National Lab complex as a whole could increase its impact through intentional cross-lab collaboration and problem solving. We also engaged with members of the National Lab Technology Transfer (NLTT) working group and members of the DOE Office of Technology Transfer (OTT) and had

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1 EFI Foundation, *Transforming the Energy Innovation Enterprise* report (2023).

2 According to the NSF, ~$19.2B in federal R&D funds were spent at the 16 FFRDC DOE labs in 2023. See https://ncses.nsf.gov/pubs/nsf24330 for more information.

conversations with others in the National Lab and DOE ecosystem to gain further input on current challenges and options for improving technology maturation and transfer success.

A Goal: Small Number, Big Difference

While increased emphasis has been placed on assisting external partners (e.g., private industry who are willing to cost share) in developing their own technologies,[3] much less emphasis is placed on maturing and transferring[4] technologies invented within the labs. Simple analysis of existing data suggests only about 15% of all patents issued to the national labs, plants and sites are licensed (see Appendix A for more information). Consequently, many nascent ideas and technologies are lost at one of several "valleys of death" along the technology maturation pathway, starting as early as low Technology Readiness Levels (TRL) 2-3. Each loss means the labs are missing out on making an even larger impact on our mission space than we do today. ***Raising the patent license rate (a quantifiable and representative metric of technology maturation) by even 1% absolute can have an outsized benefit to the US economy, our national security, energy resilience, and U.S. scientific eminence.*** It is just a matter of unlocking these benefits from work already being conducted at the labs. Our approach ultimately supports the timely transfer of National Lab capabilities to the private sector when appropriate while ensuring that U.S. investments in research do not flounder when there is clear potential for national benefit.

The Power of Connection

Previous reports,[5] have detailed pathways to enhancing technology maturation at the labs. Here, we ask the question: what are the first steps the labs can lead toward creating a more robust technology pipeline? Our answer is to leverage their individual strengths, combined suite of tools, and collective voice to set a new standard for technology maturation that will meet the nation's needs. To achieve this goal, we as OSELP Cohort 7 look forward to serving as connective tissue across the complex to organize this cohesive effort.

While technology maturation and transfer are typically considered topics of focus for the applied labs with industrial partners, our view is that they are germane to the activities of all 17 National Labs. The NNSA labs invent and develop technologies that are critical to the national security infrastructure of the country. Likewise, the labs stewarded by the Office of Science regularly innovate components and systems (e.g. detectors, electronics, vacuum systems, accelerators, etc.) that enable one-of-a-kind user facilities and cutting-edge science. Each of these missions will benefit from increased efforts advancing these technologies up the TRL scale, and ultimately to the end-user, which may be within the National Labs themselves. Lab staff will also universally

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[3] Large investments were recently made through the IRA, BIL and CHIPS acts. Several of the National Labs also host lab-embedded entrepreneurship programs (such as Cyclotron Road, Chain Reaction, West Gate and Innovation Crossroads) aimed at supporting start-ups.

[4] The term "transferring" here could apply to transfer of technologies to the private sector, US weapons stockpiles, back into the scientific infrastructure or use in some other application.

[5] EFI *supra*, note 1. *See also*, the "CRENEL Report," written in 2015 by the Commission to Review the Effectiveness of the National Energy Laboratories, which focuses on the alignment of the DOE National Labs with the DOE's strategic priorities.

benefit from training in customer discovery, which is relevant to both internal and/or external end-users.

How We Get There: Opportunities, Challenges and Paths Forward

A broad assessment of the labs and their relationships with DOE explains why technology maturation and transfer are challenging. The mission spaces (national security, basic science, and applied R&D) and cultures vary widely across the 17 National Labs, leading to differing degrees of emphasis on maturing technologies developed within them. Flowing from this overall framework, the associated principles, policies and programs they choose to implement also vary. Finally, DOE strongly influences the labs' abilities to carry out technology maturation activities. On one hand, the labs largely operate under similar bodies of regulations and directives (with some exceptions for NNSA labs). On the other hand, the labs (in conjunction with their site offices) have established different approaches and procedures for operating within them. This backdrop provides context for why and how some labs focus more on technology maturation and transfer activities than others. It also suggests that there is no one-size-fits-all approach that could or should be adopted across the National Lab complex.

Instead of a prescribed approach, the National Labs have the best chance to move the needle by leveraging their individual strengths and shared goals to bolster the technology maturation programs of others and solve common challenges. While the NLTT works together to address specific issues, input from across the labs has identified several topics that could still benefit from additional focus. In fact, many of the suggestions we collected are creative and reflect on what the labs are capable of collectively rather than as individual entities. Input from around the lab complex broadly fit into a few categories, ranging from work the labs can take on themselves to ones that require partnership with DOE. More specific suggestions are included in Appendix B.

Adjusting Mindset to Foster More Innovation

Researchers can easily fall into the mindset that delivering on DOE program expectations, whether that is a technical milestone, a scientific paper, or a new capability for the national security mission, are the full extent of what is possible in their role at a national lab. Reinforcing the message that their work may also reach and impact future end uses through various labs, DOE and industry-led programs may expand their vision and focus. Educating researchers on the pathways to maturing and transferring technology, improving incentives for filing records of invention, providing additional support for customer discovery, and lowering barriers to entrepreneurship are all ways to help researchers automatically consider end uses and requirements at every stage of their work and proactively seek out maturation pathways. A recent study that surveyed six National Labs found widely varying innovation cultures. This study also found that technology transfer education effectively tripled labs' innovation culture.[6]

[6] From the Office of Technology Transitions' 2021 report entitled *Entrepreneurial Thinking: Historical and Observational Study* completed by Idaho National Laboratory.

Sharing Best Practices and Programs Between Labs

Some individual labs have created impactful programs that educate researchers on the importance of technology transfer, train them on customer discovery, provide funding for maturing technology beyond TRL 3-4 levels, and identify outlets for lab-generated IP to be commercialized and/or reach end users (which may be internal to the DOE, DoD, and other agencies). Other labs could benefit from adopting these programs as well. Compiling a list of programs and providing input on how best to implement them would be an appropriate starting point for broadening participation in technology maturation at all labs.

An addition to running their own internal technology maturation and transfer programs, labs could work together on larger initiatives. Suggestions included bundling IP across labs to make it more attractive for licensing and creating Energy I-Corps teams from members at different labs to build momentum for specific topics and share ideas.

Collective Advocacy

The greatest challenges, and the ones that will yield the greatest impact if addressed, lie with the policies enacted by DOE. Examples include, but are not limited to, the rigid operating structure set forth by the Federal Acquisition Regulation (FAR), regulations on receiving non-appropriated funding, and caps on funding for tech transfer activities. Such comprehensive and inflexible directives can slow down partnership and licensing mechanisms that are vital to technology maturation and transfer. As one NLTT member noted, "A unified voice is probably the only thing that will bring about any significant (non-incremental) improvements." One potential place to start is to adjust M&O contracts to change how funds are received from non-FAR sources. Adoption of Other Transaction Authority (OTAs) if possible can also speed up and add flexibility in cases where it is warranted and needed. Additionally, the labs could provide data to the DOE to inform the direction of new policies. Advocacy plans that anticipate the evolving nature of the DOE and other stakeholders (e.g., as more public-private partnerships are encouraged in various sectors) and the development of robust constituencies that rely on their work will set the labs up to evolve with them and continue to deliver impact to the sectors they support. Policies could be put in place that streamline the ability of domestic industry to more easily benefit from IP generated from the National Labs and to mature technology to ensure international competitiveness.

Adjusting Existing Program Scope and Structure in Partnership with DOE

Restructuring existing programs led by the DOE could deliver more benefit to the labs and reduce current barriers. A number of suggestions centered around making modifications to the Technology Commercialization Fund (TCF) program and expanding voucher programs (see details in Appendix B). Other suggestions include reducing partner cost share to involve more start-ups in DOE-funded programs and increasing funding for technoeconomic analysis and lifecycle analysis to support commercialization decisions. Regularly evaluating the effectiveness of these programs, with input from the DOE and the labs, will help to ensure that these programs are delivering sufficient impact and are avoiding new challenges or barriers that arise as the DOE funding landscape evolves.

Creating New Programs

The LDRD program has been immensely successful at generating new research directions and capabilities for the labs. However, funding is aimed at technologies in the TRL 0-4 range. A new category of LDRD ((Lab Directed Technology Maturation) proposed in the EFI study and aimed at technology maturation (TRLs 4-6) would help ideas developed under traditional LDRD and DOE support to more effectively and quickly span the technology “valley of death.” An applied-emphasis LDRD program could especially help the applied energy labs to mature technologies that benefit industry and ensure energy security. Another approach could be for the science labs to partner with the applied and NNSA labs to more effectively identify end uses for early stage (TRL 1-2) innovations and mature them collectively. Expanding formal training programs and financial support of entrepreneurs at every lab to take technologies out of the lab will also create new avenues for commercializing technologies beyond simply licensing IP to larger existing companies. ARPA-E data suggest that the success rate for commercializing new ideas can be much higher if a start-up was involved, in part because their existence depended on it. One option would be to deliberately involve lab-based entrepreneurs in the lab embedded entrepreneurship programs (LEEP) run by the DOE and labs. This approach would require additional focus on creating robust yet accommodating conflict of interest policies (see below for more discussion).

Regularly Requesting Input and Acting On It

The evolving landscape in which the national labs operate—including new legislation and federal policies; the increasing urgency to support national security, science, and clean energy transition missions; and shifting needs in industry—will require them to be agile in their own approaches to innovation and technology maturation. Seeking regular input from external reviewers could help to identify blind spots or opportunities to further refine their own programs. The EFI report is one example of a holistic review that delivers recommendations for increasing the national labs’ impact on energy innovation. Carefully considering such reports and studies (and commissioning new ones) will give the labs the best chance to respond to an ever-shifting set of needs and priorities.

Encouraging “Big Swings”

The opportunities detailed above all involve some level of risk taking by the National Labs, whether it is developing new ways to address potential conflicts of interest associated with spinning technologies out of the labs or finding additional funding for technology maturation. Working in partnership with each other and the DOE to assess those risks and identify which ones are acceptable will be an important step in enabling the types of changes detailed above—making real progress toward increasing the impact the National Labs have on the U.S. society and economy.

Figure 1 summarizes the opportunities highlighted here to enhance technology maturation and transfer at the National Labs.

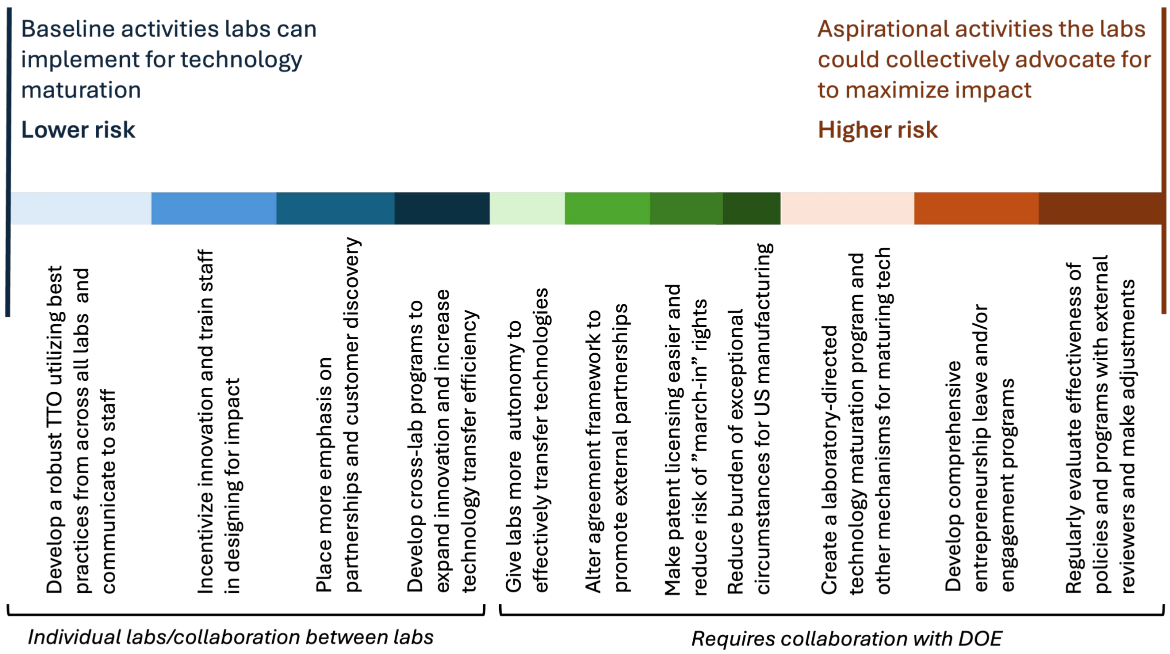

Figure 1: Examples of actions labs could take individually or collectively to enhance their technology maturation and transfer activities and increase the impact of their work on U.S. national and economic security. Actions increase in complexity and risk moving from left to right.

Each lab has a different starting point. Some aspects can be implemented by individual labs and tailored to suit their needs (for example, altering incentives for innovation and implementing new technology maturation programs), while others will require the labs to work together (for example, bundling IP or creating cross-lab Energy I-Corps teams). Further progress must be made in partnership with DOE to update policies and program structures to take further advantage of more of the labs' expertise, capabilities and innovative ideas.

Conclusion

Technology maturation and transfer are critical aspects of the DOE National Laboratories' missions to advance US economic, energy, and security interests. The labs already produce outsized impact in each of these areas but could achieve even more with a greater emphasis on these topics and modest adjustments in associated policies and programs.

Importantly, staff within the National Labs (ranging from individual researchers to lab leadership) have interest and passion to work on increasing the effectiveness of technology maturation and transfer mechanisms. Combining efforts across the labs has the potential to substantially increase the benefit R&D at the labs delivers to the US public. We look forward to supporting and contributing to this mission.

Appendix A: A Look at Patent Licensing

Patent activities at the labs provide one (but not the only) view into the extent of technology maturation at the labs. In FY2020 (the latest year for which DOE-wide metrics are available), researchers at the 21 national labs, plants and sites submitted 2,021 invention disclosures, filed 956 patent applications and added 141 income bearing licenses to a pool of 2,772 active income bearing licenses. In simplified terms, this data suggests the national labs license a small fraction of the IP in the portfolio. This data was compiled from the Federal Laboratory Technology Transfer Fiscal Year 2020 report.[7] To truly use patent licensing as an indicator for technology maturation, a broader analysis of trends over many years would be needed. An additional caveat to this approach is that there is a significant time constant for IP to be filed and a license to be negotiated. It often takes 5-10 years for national lab IP to mature to a point where it is licensed.

[7] Federal Laboratory Technology Transfer Fiscal Year 2020 report, prepared by the National Institute of Standards and Technology.

Appendix B: Challenges and Suggestions Collected from the Labs

1. **Share Best Practices and Activities Across Labs**
   - **Support for lab inventors**:
     - **Challenge:** Lab researchers may not know about technology maturation and transfer options or connect the importance of these functions to their lab missions. Lack of awareness results in fewer patents and lower success in technology transfer.
     - **Suggestion:** Promote technology maturation and transfer programs at each lab. Incentivize lab staff to utilize these programs and build IP generation into projects.
     - **Challenge**: Lack of funding and business support for lab inventors made it difficult for them to mature their technologies for public sector transfer.
     - **Suggestion**: Share best practices for funding and supporting lab inventors. Include grants, business development support, and access to commercialization resources.
   - **Develop technology maturation programs with industry**
     - **Challenge**: Finding non-federal funding for technology maturation can be difficult.
     - **Suggestion**: Share best practices for establishing novel partnership programs with industry that expand array of funding options (for example, Wells Fargo IN2, Shell Game Changer powered by NREL, Chevron Studio).
   - **Bundling IP and capabilities**:
     - **Challenge**: Absence of programs to bundle lab IP and capabilities across the lab complex hindered collaborative development and derisking of technologies.
     - **Suggestion**: Develop programs to bundle lab IP and capabilities across labs. Create cross-lab teams, jointly develop projects, and centralize management of bundled IP.
   - **Expand energy I-Corps teams**
     - **Challenge**: Insufficient funding[8] and teaming challenges for Energy I-Corps teams has limited their ability to conduct customer discovery and design strategic proposals that address market needs.
     - **Suggestion**: While the EIC has supported Energy I-Corps teams composed of members from different labs, it may be beneficial to expand this approach and foster cross-lab teaming. Enhancing funding for strategic proposal development and creating well-defined networks of mentors and advisors could also add value.
   - **Protect sensitive technologies**
     - **Challenge**: Inadequate protection for sensitive technologies through patents, copyrights, and know-how left valuable innovations vulnerable and less attractive to

[8] In FY25, the EIC program will increase funding for teams from $80K to $100K, which will help to alleviate some of the funding challenges.

industry partners. Pushing labs to license IP for free devalued the technology and limited its impact.

- **Suggestion**: Implement policies to protect sensitive technologies through patents, copyrights, and know-how. Develop training programs for lab staff on IP protection and establish clear guidelines for licensing and commercialization.

- **New data/information classifications**
  - **Challenge**: Lack of appropriate data/information classifications hinder the formation of targeted commercial partnerships as well as the protection of sensitive information.
  - **Suggestion**: Propose new data/information classifications that align with the S&T Risk Matrix. Draft recommendations, consult with legal experts, and pilot the new classifications in select labs.

2. **Collective Advocacy**

- **Policies that provide more flexibility**
  - **Challenge**: Rigid policies and directives (like FAR) restrict the flexibility of TTOs, making it difficult to adapt to new opportunities and challenges compared to more flexible entities like universities.
  - **Suggestion**: Lower the large amount of oversight and burdens that impede effective technology transfer. Form a task force to review and recommend changes to existing policies and directives. Include representatives from TTOs, industry partners, and policymakers to ensure comprehensive and feasible recommendations.
  - **Challenge:** DOE has imposed several additional requirements and oversight burdens on the national labs that significantly slow and impede the effective transfer of technologies to the private sector for commercialization.
  - **Suggestion:** Give the national labs the autonomy they need to effectively commercialize their technologies at the speed and scale needed by industry.

- **Policies that allow access to alternative funding**
  - **Challenge**: Existing policies did not allow labs to receive funds from non-appropriated sources, limiting their ability to leverage flexible funding mechanisms like OTAs.
  - **Suggestion**: Advocate for the adoption of policies that allow labs to receive non-FAR funds. Present case studies of successful OTAs and highlight the benefits.

- **Increase in allowable tech transfer costs**
  - **Challenge**: Current cap on tech transfer costs limited the resources available for these activities, slowing down the commercialization process.
  - **Suggestion**: Advocate for an increase in allowable tech transfer costs to 1% of lab operating funds. Present data on the impact of current limitations and engage with budgetary authorities to secure approval.

3. **Adjust Existing Program Scope and Structure in Partnership with DOE**

- Technology commercialization fund (TCF)
  - **Challenge**: The TCF is a valuable tool for maturing technologies developed at the labs. Some interviewees perceived that the TCF lab call has substantially increased in complexity. The reporting burdens have also significantly increased to the point where awardees spend more time reporting on progress to DOE than they spend on maturation and development work.
  - **Suggestion**: Reform and streamline the TCF lab calls with simpler language and lower reporting requirements. Develop a unified application process and set clear priorities for the maturation and development of national lab technologies.
  - **Challenge**: The TCF tech maturation program has expanded towards commercialization enabling projects, creating a perception that it has reduced its focus on advancing lab-developed technologies to market.
  - **Suggestion**: Ensure focus isn't lost on traditional tech maturation within the TCF program. Establish clear guidelines and metrics to ensure projects are aimed at advancing lab-developed technologies to market readiness.
- Agreements for Commercializing Technology (ACT)
  - **Challenge:** ACT agreements allow labs to conduct privately-sponsored research with more flexibility in the terms of the contract. It has proven to be successful for promoting industrial collaborations but can only be used for private funds.
  - **Suggestion:** Expand the use of ACT agreements to promote easy access of national lab capabilities by the private sector. Expand FedACT to allow federal funds to be used in ACT.
- Cooperative Research and Development Agreements (CRADA)
  - **Challenge:** CRADAs are a major partnering mechanism that is used in an increasing array of partnerships between labs and external partners, even when research is federally funded. CRADAs take a long time to approve in the case of complex partnerships.
  - **Suggestion:** Expand the use of Master Scope of Work CRADAs for use in industry-national lab consortia like Agile BioFoundry to accelerate partnerships within defined technical areas, thus reducing administrative delays related to DOE reviews and approvals.
- Reduce the use of 'march-in' rights
  - **Challenge**: The Bayh-Dole Act allows universities, national labs, and small businesses to own patents they develop using federal research funds, while the U.S. government reserves a right to 'march-in' to practice those inventions in extreme cases. The march-in rights were never intended to be used to control prices, but activist groups are now petitioning the U.S. government to use these rights to violate private sector patent rights. This would have a drastic negative effect in the cleantech space by scarring off private equity investments in promising early-stage

energy innovations and would negatively impact industry partnerships at national labs.

- **Suggestion**: Discourage the use of 'march-in' rights in such instances.

- **Adjust the use of 'exceptional circumstances' for U.S. manufacturing requirements**
  - **Challenge**: DOE determination of exceptional circumstances imposes more stringent U.S. manufacturing provisions on licensees of DOE technologies than what is prescribed in the law. Startup companies have to manufacture where commercially feasible and while most support U.S. manufacturing, it is often not possible. The new DOE requirements discourage otherwise promising startup licensee candidates from investing in the commercialization of DOE funded technologies. Those existing startups struggle to raise funds with this new requirement, because production has now been separated from economic feasibility.
  - **Suggestion**: Ease U.S. manufacturing requirements to better align with the prescribed laws to encourage commercialization of DOE funded technologies.
- **Reduce industry partner cost share**
  - **Challenge**: High industry partner cost shares discouraged participation from smaller companies, limiting collaboration and innovation.
  - **Suggestion**: Propose a policy change to reduce the industry partner cost share to 20% or less. Engage stakeholders and present data on the benefits of increased participation from smaller companies.
- **Voucher programs**
  - **Challenge**: High cost of doing business with labs was prohibitive for small businesses and entrepreneurs, limiting their ability to partner with labs and commercialize technologies.
  - **Suggestion**: Establish voucher programs to help small businesses and entrepreneurs partner with labs. Provide financial support for lab services and reduce cost barriers for these partnerships.
- **Techno-economic and lifecycle analysis funding**
  - **Challenge**: Insufficient funding for techno-economic and lifecycle analysis left many promising technologies without the necessary support to succeed in the market.
  - **Suggestion**: Secure dedicated funding for techno-economic and lifecycle analysis. Increase federal funding or partner with industry to co-fund these activities.
- **Build IP generation into funding**
  - **Challenge**: Programs often failed to balance funding for open science with industry-focused research, leading to insufficient incentives for innovation and IP generation.
  - **Suggestion**: Develop funding programs that balance open science with industry-focused research. Set aside specific funds for IP generation and protection and create incentives for researchers to engage in these activities.

4. Create new programs

- **Entrepreneurial engagement**
  - **Challenge**: Lack of formalized programs for researchers to engage with startups and manage conflicts of interest limited the potential for successful commercialization of lab innovations. These programs are inconsistent, and requirements vary across the labs and programs. Insufficient funding for techno-economic and lifecycle analysis has also left many promising technologies without necessary support.
  - **Suggestion 1:** Consistent guidance on conflicts of interest mitigation will help labs and program offices manage issues that may arise while being able to effectively partner with startups commercializing national lab technologies.
  - **Suggestion 2**: Establish formal programs to support entrepreneurial engagement. Include mentorship programs, funding for techno-economic and lifecycle analysis, and conflict of interest management frameworks.
  - **Suggestion 3**: Create and communicate clear entrepreneurial leave of absence policies that make it possible for researchers to step away from the lab to commercialize technology invented at the labs. Consistent application of leave programs with a broad consensus with the DOE on how conflict of interest can be managed and mitigated would go a long way of making material improvements to National Lab startups.
- **Laboratory directed technology maturation program**:
  - **Challenge**: Absence of a formal program for TRL 5-7 activities left a gap in funding and support for technologies in this critical development stage, making it harder to bridge the "valley of death."
  - **Suggestion**: Develop a proposal for a formal Laboratory Directed Technology Maturation program. Outline the benefits, funding requirements, and implementation plan, and present to DOE leadership for approval.

5. **Long-term agility**

- **Periodic assessment of challenges**
  - **Challenge**: The slow pace of policy change failed to keep up with the evolving DOE landscape and the rise of industrial policy in clean energy, hindering progress.
  - **Suggestion**: Develop a long-term advocacy plan to address the evolving DOE landscape. Include milestones for policy changes and strategies for engaging with key stakeholders and decision-makers.
- **Energy Futures Initiative report**:
  - **Challenge**: Despite valuable insights and recommendations, little action has been taken to date to implement these suggestions, limiting their impact.
  - **Suggestion**: Organize workshops and seminars to discuss the findings of the Energy Futures Initiative report. Develop an action plan to implement the report's recommendations, with clear timelines and responsibilities.

Our Learning Journey into the Laboratory Directed Research & Development (LDRD) Program

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Introduction to LDRD Programs

In the United States, the U.S. Congress creates funding bills for the President to sign and these bills direct how the funds will be spent. U.S. national laboratories are given a unique ability to direct a small portion of their indirect funds to make institutional investments. These Laboratory Directed Research & Development (LDRD) funds are accrued in accordance with the laboratory's management and operating contracts and must be used in the same fiscal year as the principal funds were awarded. The LDRD program was authorized by Congress in 1991 and updated in 2020 to include the one government-owned government-operated (GOGO) laboratory. The details of how the Department of Energy (DOE) has implemented the program can be found in DOE Order 413.2C.

The LDRD program creates a unique way for the 17 national laboratories to support innovative and cutting-edge projects to ensure that the complex stays at the forefront of science and technology. The three primary objectives of the LDRD program are:

1. **Mission Agility**: Enable agile responses to national security, energy, and environmental challenges.
2. **Scientific and Technical Vitality**: Advance the frontiers of science, technology, and engineering.
3. **Workforce Development**: Attract, retain, and develop tomorrow's scientific and technical workforce.

As with any program, it is important to identify performance indicators that are used for identifying a successful LDRD program. From the DOE point of view, the performance is nominally determined by reviewing the following four criteria:

1. Number of postdoctoral researchers supported by LDRD
2. Number of peer reviewed publications associated with the LDRD projects
3. Number of patents granted associated with LDRD projects
4. Number of invention disclosures associated with LDRD projects

These metrics can be gathered on an annual time scale. While one can also point to Nobel prizes (e.g., two winners at Lawrence Berkeley National Laboratory who started with LDRD funding) and other indicators like royalties or paper citations, these are very lagging indicators and hard to use when evaluating the current program.

The National Nuclear Security Administration (NNSA) laboratories are required to invest a minimum of 5% of their base budget into LDRD, and all laboratories have a cap of 6%. Each laboratory's LDRD program is funded through overhead/indirect funding. The GOGO laboratory does this differently and only recently started their LDRD program, though already has a $1.2 million program in place. Due to the different missions of the 17 national labs, what is considered an appropriate LDRD project at one laboratory might fall into the mission space of another laboratory. While there is no hard and fast rule on exactly where the technology readiness level (TRL) should stop to be within the scope of LDRD, an interesting rule of thumb would be the point at which a patent can be granted. Regardless of this exact point, the end of LDRD funding is often short of the point where an idea can be taken over by industry, which leads to the "valley of death." This is addressed in our Cohort's technology-transfer Think Piece.

DOE maintains close oversight of LDRD programs to ensure compliance and relevance to the broader DOE missions. Nevertheless, the laboratories have a lot of freedom in the way they execute their programs, e.g., laboratories can pool their funds into one or two large projects or divide into many projects (as is more typical). The nominal 36-month limit for an LDRD project was put into the language of the original authorization to make sure laboratories do not use LDRD funds to permanently fund projects and/or researchers, though it is important to note that DOE is sympathetic to real-world problems and does give short extensions if a persuasive case can be made. The effects of the COVID pandemic, in particular, caused a short-term spike in the number of granted exceptions.

Finally, it was noted that LDRD projects must benefit the agency(ies) providing funding and that Congress has periodically sought further information on the program, given the sensitivity around the laboratory-directed concept.

Best Practices

One amazing resource discovered is the LDRD Best Practices web site: https://bestldrd.labworks.org/. While this web site was clearly set up to help LDRD leadership from across the complex see each other's best ideas, we found it was a useful tool for learning about what makes a successful LDRD project. In particular, we found the "return on investment' scorecard Savannah River National Laboratory has instituted to be a very nice and consistent way for a lab to judge the effectiveness of its program. It is worth noting that due to the very different missions of the labs, a single score sheet likely isn't appropriate, nevertheless, the idea could certainly be customized to reflect the priorities of any given laboratory and create a consistent way of tracking short-term LDRD impact.

In reviewing the best practices site, it is also clear that due to the scale of budgets, what is a "best practice" at one laboratory is completely impractical at another. One example of this is the very nice "exploratory express" (EE) LDRD concept at Sandia National Laboratories, which allows small projects with budgets up to $100,000 to process quickly. At a small laboratory, an EE-scale LDRD is a typical LDRD project. On the other hand, the idea of having some funds available for small, short-time-scale projects is intriguing even if the monetary scale needs to be different from lab to lab. Not all challenges, however, may be tackled by means of exploratory or even full-size LDRD projects at a single laboratory. Some challenges, such as incorporating the use of artificial intelligence for scientific discovery, likely require a coordinated effort that calls for contributions from multiple, if not all, the national laboratories.

Grand Challenges

As an Oppenheimer cohort, we are mindful of the remarkable work accomplished during the World War II-era Manhattan Project, which inspired the idea that in times of special national need, it would benefit the nation if the laboratories could easily collaborate on a common LDRD project. While it is not yet feasible for all 17 national laboratories to participate in such a manner, the three NNSA laboratories, along with a few others, have successfully initiated a multi-lab LDRD process that is growing each year. Although this process does not yet allow all 17 laboratories to work on a single project, it does facilitate easier collaboration and the combination of individual expertise on common goals.

The primary challenge with multi-lab projects has been logistics. So far, six laboratories have joined the multi-lab program, with up to four laboratories collaborating on any single project. The DOE has received positive feedback indicating that bringing laboratories together leads to more successful projects, exemplifying how diversity enhances outcomes. Additionally, we learned that laboratories will soon have more freedom to allocate funds to a technology maturation program through overhead funds.

The diversity of the 17 national laboratories affords a unique opportunity associated with multi-lab LDRD projects. This opportunity is based on the observation that a basic science LDRD project at an NNSA laboratory may look like an applied science project at an Office of Science laboratory; a change in perspective due in part to the individual labs' missions and needs and in part to the expertise of the population at each laboratory. For example, at Sandia National Laboratories, personnel assigned to an engineering job category outnumber significantly those personnel assigned to a science job category. In contrast, at Fermilab and Jefferson Lab, that ratio is much closer one-to-one.

Such a capability distribution means that, collectively, multiple national laboratories can transition a new discovery from basic science to a prototype or pilot demonstration in a way that may be difficult for a single national laboratory. In effect, what exists across the national-laboratory system today is the equivalent of the storied Bell System organization that invented and developed world changing transistor technology (J.A. Morton, 1971; J. Gertner, 2012). Thus, for instance, a basic research insight that might originate at Fermilab may be developed further by national laboratories that emphasize applied research and eventually demonstrated as a prototype with the aid of Sandia National Laboratories.

The national laboratories are well positioned to execute a co-design approach to research and development. Co-design creates the opportunity for conceiving and developing ideas collectively. In co-design, the basic research, applied research, and development and design associated with a new idea inform and engage with each other (J.A. Morton, 1971). Using microelectronics as the example, co-design means that "materials scientists, chemists, device physicists and engineers, circuit designers, and micro-architects, on up to language, algorithm, and even application designers [...] work across the traditional layers of abstraction." (BRN for Microelectronics, 2018) When appropriate, DOE NNSA production plants, e.g., the Kansas City National Security Campus (KCNSC), may be recruited to supply production manufacturability expertise, completing the Bell System metaphor.

Realizing this kind of research and development co-design vision at the national scale comes with variety of challenges, some specific to the LDRD program and some generic. The table below enumerates the most significant ones and suggests optional paths forward.

Challenge	***Option(s)***
Disparate sizes of LDRD programs at national laboratories	• Start with multi-lab LDRD projects between similar-size national laboratories (e.g., small, medium, and large). • Implement a process to efficiently move LDRD funds between national laboratories to match resources to tasks on national-scale projects.
Effective IT solutions for sharing methods and data	• Expand current IT solutions hosted at the Pacific Northwest National Laboratory (PNNL). • Host data and project related information at a trusted single point such as the High Performance Data Facility (HPDF) at the Thomas Jefferson National Accelerator Facility. • Enable solutions for sharing UUR and CUI contents.
Increased demand on each national laboratory's LDRD office	• The effort to manage a local portion of a national-scale multi-lab LDRD project is likely to demand a minimum level of effort. • Implement a process to efficiently move LDRD funds between national laboratories to match resources to tasks on national-scale projects.
Distinct organizational cultures, tools, and languages associated with different communities of specialists and national laboratories	• Start with multi-lab teams that minimize the distinctions, e.g., similarly sized Office of Science laboratories with overlapping research interests. Then expand to multi-lab teams that include national laboratories across the DOE (e.g., SC, EERE, and NNSA). • Create opportunities for individual research staff to network across all 17 national laboratories.
Distributed workforce, no co-location	• As OSELP demonstrates, assembling a cohort from all 17 national laboratories at each national laboratory or via virtual meetings is eminently feasible.
Variable approaches to supporting technical personnel while developing multi-lab LDRD project.	• Develop a uniform process for proposal development that does not require "nights and weekends" efforts. Complex, national-scale multi-lab LDRD projects can be expected to require substantial up-front planning.

We anticipate the following benefits from a national-scale Grand Challenge multi-lab LDRD construct:

- Realization of radically new capabilities that would not have resulted from decoupled LDRD efforts. Examples could include: (i) Deployment of artificial intelligence and autonomy in science and applied research; (ii) secure energy supply and grid innovation; or (iii) a cure for acute radiation poisoning. Focus areas similar to these are already drawing interest from six national laboratories that are part of the 2025 multi-lab call for proposals.

- National laboratory staff networking through extending the already successfully demonstrated multi-lab LDRD networking events to all 17 national laboratories. We assess that this type of get-to-know-your-peers mechanism possesses tremendous intrinsic value. This value is further enhanced by the potential of putting new relationships to use in a funded multi-lab LDRD project.
- Maximum Team R&D. Developing a national laboratory workforce with T-shaped skillsets that are not a natural outcome of specialized academic programs. By identifying national-scale grand challenges, we anticipate the consequent growth of interdisciplinary lateral skillsets across basic science disciplines, applied science disciplines, or engineering disciplines as well as vertical skillsets, e.g., across basic science and engineering.

We suggest that a practical path to a national-scale Grand Challenge multi-lab LDRD project starts with the following:

1. Growing the current multi-lab LDRD program through encouraging multi-lab teams among similarly sized national laboratories with common focus areas of interest. Proposed owners: National laboratory Chief Research Officers and respective LDRD offices.
2. Networking sessions can be extended to all 17 national laboratories immediately, even before the multi-lab LDRD program is fully implemented across all labs. Proposed owners: National laboratory Chief Research Officers and respective LDRD offices.
3. Ultimately, achieving a national scale multi-lab LDRD project requires decoupling demand for each laboratory’s capabilities and capacities from a supply constrained by the LDRD resources available at each laboratory.

Final Thoughts / Conclusion

The DOE LDRD program is unique as it allows national laboratory leadership to allocate funds, a task typically reserved for Congress. With this ability, though, comes the responsibility to spend the funds wisely. It was clear that all laboratories value LDRD funds and the benefits that the LDRD program brings, especially by allowing each national laboratory to make investments for the future that wouldn’t be possible otherwise.

The NNSA labs and several of the other larger national laboratories have started to partner on multi-lab LDRD projects. Multi-lab LDRD projects allow the participating laboratories to each contribute their own specialized skills and unique capabilities. For the national laboratories that are not yet involved in the multi-lab LDRD program, especially the laboratories with small LDRD budgets, it may be more challenging though not impossible to also set up multi-lab LDRD projects. Nonetheless, it was clear from the data we gathered that the DOE values such collaborative projects.

It is worth noting that many of the laboratories seem comfortable with how they are distributing their LDRD funds. We suggest that it is probably always worth reflecting on if last year's allocation among different types of projects is the best use of the funds especially if a unique opportunity or national need arises that going "all in" to one project or theme could be the best course of action.

Finally, the multi-lab LDRD program and, at its upper bound, national LDRD Grand Challenges, represent an opportunity to add another "swimlane" to the national laboratories' collective history, to be populated by future accomplishments modeled after the Manhattan Project.

Acknowledgments

We wish to acknowledge the candid and open discussions about the LDRD programs that we had during our visits with the seventeen national labs. Our cohort's journey started this year at Oak Ridge National Laboratory, and it was their discussions about the size and scope of their program that got our group interested in learning more about the program and learning more about what is possible within the rules of the program. Special thanks to Marianne Walck, Director of NETL, for pointing out the special challenges the GOGO lab faced in order to start an LDRD program, to Andy Nelson, SNL, for discussing the current status and practices of the multi-laboratory LDRD program, and to John LaBarge, Alice Wang, and Jason Albert from the Office of Science for providing us insight into the Departments of Energy's oversight of the program.

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AI for Science:
Shaping the Future of the National Lab Complex

This Think Piece is dedicated to Charlie McMillan, former LANL Laboratory Director and OSELP Mentor, who inspired us during our Los Alamos visit to work on this topic. He is deeply missed.

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Introduction

Developments in Artificial Intelligence (AI) have accelerated at breathtaking speed in the last couple of years. From whimsical text-based image generation (Figure 1) to advanced logic and programming skills, AI technologies have rapidly evolved. The birth and remarkably fast development of generative AI tools like ChatGPT, Copilot, and Gemini caught many by surprise and has ushered in an industrial and nation-state race for technological supremacy. Such rapid advancements have rarely been seen, with technology companies assuming powers traditionally reserved for nation-states. This shift is complicating the global security stage and potentially changing the future of scientific research.

***Figure 1**: ChatGPT's vision of the impact of AI on DOE in the next five years.*

Recent times have seen rapid development in the creation of Foundation Models. This includes large language models like GPT 3.5, LlaMA, Gemini, and others; but more broadly have additional capabilities such as query and image classification. These models were trained on massive datasets (trillions of parameters) and are highly adaptable and multimodal, meaning they not only process text, but also video, images, and audio. A unique aspect of Foundation Models is their use as base models in the development of specialized or single-purpose models. Thus, access to Foundation Models can greatly accelerate the adoption and utilization of AI for organizational needs. Figure 2, acquired from Stanford University's annual AI Index Report (2024), shows not only the rapid growth in the number of large Foundation Models but also that industry far outpaces government in the development and ownership of these models (these data are limited to openly public models). Similar to the development of the moving assembly line by Henry Ford in 1913, which helped to revolutionize US industries, the limited involvement of government bureaucracy may have allowed industries' rapid adoption of new technology. While government (including national laboratories) may not be leading the development, given the deep penetration of AI into a multitude of sectors and its wide-spread applicability, it is vital the national laboratories leverage the progress that has been made and gain a better understanding of how AI can contribute to the multiple missions of the Department of Energy (DOE).

While recent developments in AI could lead to major advances in science, for the national lab complex its adoption will also pose major challenges. Given the rapid pace with which AI currently proceeds, a Think Piece that provides recommendations of any kind would be either quickly outdated or so nonspecific that it would not add anything useful to the current discussions. For example, within the timeframe of the Oppenheimer Science and Energy Leadership Program (OSELP) Cohort 7 experience, DOE announced its roadmap for "Frontiers in Artificial Intelligence for Science, Security and Technology (FASST)" [1]. This initiative aims to address four critical areas for wider adoption of AI throughout DOE and the broader scientific and technological communities. In particular, FASST will aid in transforming vast stockpiles of scientific data to be AI-ready to assist in the development of both Foundational and specialized models. FASST will provide resources for the development of energy efficient platforms and algorithms to reduce or eliminate carbon emissions from the vast computational resources needed to drive AI innovation and adoption. Beyond scaling AI for widespread adoption, FASST will provide resources to ensure

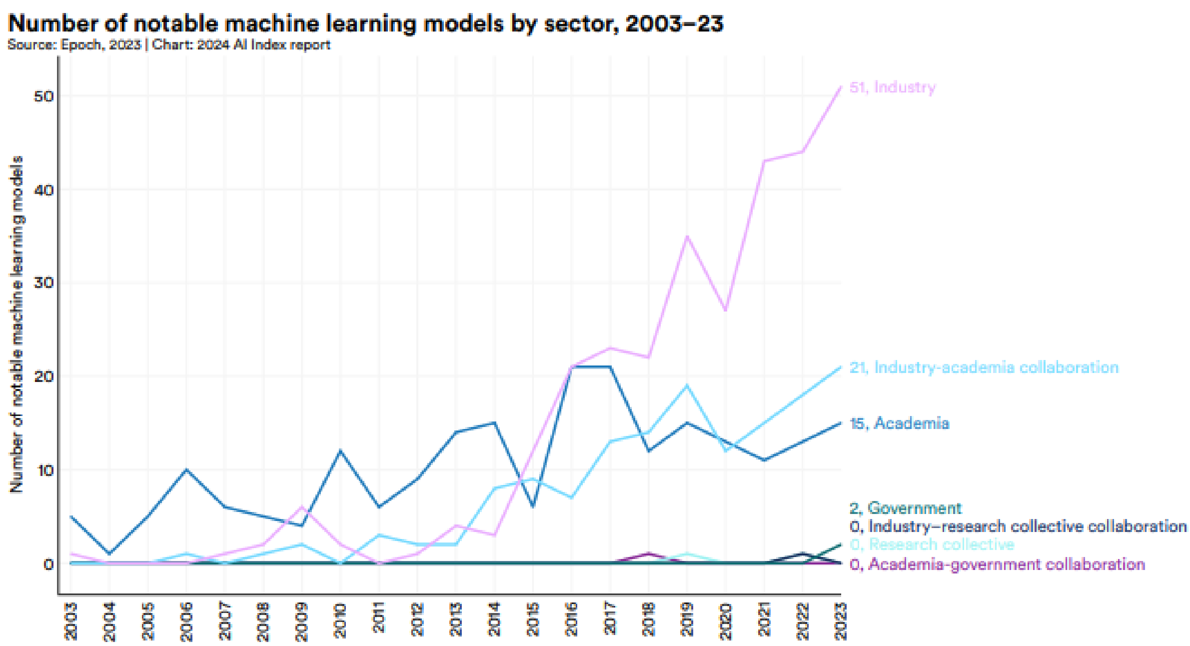

***Figure 2**: Rapid growth in the number of large Foundation Models.*

AI model integrity, trustworthiness, and safety. The final aspect of FASST is in AI application development to assist with the DOE mission of scientific exploration, sustainable energy, and national security [2].

Machine Learning (ML) is one aspect of AI that is deeply rooted in scientific research. ML based approaches (neural networks, etc.), typically rely on large datasets in order to accurately train models for solving potentially complex problems. Common approaches for training models include exposing neural networks to domain specific data in a manner of supervised, semi-supervised or unsupervised learning depending on the state of data. All of these techniques rely on very large domain specific datasets to accurately train an ML based model to address a specific challenge. Even within the vast confines of the national laboratory complex, access and/or availability of such datasets may present a challenge. An alternative approach that may be more accessible, given the widely diverse domain expertise that exists across the national laboratories, is Transfer Learning. The idea of Transfer Learning is to leverage a pre-trained model intended for use on a specific task in the development of a model for a separate but related task [3]. This approach has the potential of significantly reducing the demands for curated data, as well as reducing the time and investment in developing the new model. More so than industry, the national laboratory complex with its vast array of domain-specific expertise and access to disparate datasets may be able to leverage Transfer Learning better than industry. This could offer an approach that may accelerate the development of Foundational Models across the national laboratories aimed at addressing the unique scientific and technological challenges that construct the DOE mission space.

Given the rapid progress in AI, members of OSELP Cohort 7 have developed a Think Piece that focuses on how AI might shape and impact the national lab complex in the next five years. Three pressing questions are being discussed in this context:

- **Working efficiently across the national lab complex and connecting with industry**: Due to the gravity of their work, the national laboratories often move at a pace slower than what has recently been observed in AI development. If the national laboratories are to assume a leadership role in the application of AI for science and national security, how can they adopt an approach consistent with the rapid pace of development? Collaboration across the national laboratory complex, as well as with industry and academia could help accelerate the development of impactful best practices.
- **Data sharing and curation**: How can we efficiently share scientific data and work across the laboratories to enable transformational results from the wealth of data we own?
- **Reliable and ethical AI**: How can the national laboratories work together to ensure results based on AI methods are reliable and follow stringent scientific metrics?

The Think Piece is based on information gathered via a multi-laboratory questionnaire, from recent reports [4], open literature [5] and lectures/discussions presented to OSELP participants during laboratory visits. We highlight important opportunities and summarize major challenges, not only from a scientific perspective but also from an ethical point of view that will ensure the integrity of our results.

Finally, we have developed a "Data Challenge Case Study." We describe a concrete challenge that would bring together domain and computer scientists to gather a body of data across many national laboratories and curate the data. Such a challenge would start to address the first two questions proposed in this Think Piece and emphasize the importance of working efficiently across the laboratory complex.

Information Gathering

Just as the field of AI is developing with unprecedented speed, so is the amount of information, opinion pieces and speculations about the possible impact of AI. Some of this information is hyped in support of a rapidly growing AI industry, but the national laboratories must be willing to sort through the noise to uncover the relevant science and business practices if they are to assume their customary role as a leader in the scientific community. For this Think Piece, we gathered information in three different ways: (i) we surveyed several recent reports we believe are relevant to DOE and the laboratories (see references), (ii) we compiled information from multiple sources provided during our site visits, and (iii) we developed a questionnaire that was distributed to an wide spectrum of personnel from across all the National Labs.

The questionnaire had simple multiple-choice questions targeting AI for Science and provided participants the opportunity to share additional thoughts through write-in comments. We identified at least one person at each lab (for some labs we sent the questionnaire to more than one person) and covered different levels of positions. We wanted to hear from some of the AI leadership and management at the labs but also from scientists on the ground who often have more practical concerns about how to expand the role of AI at the labs. We targeted a balance between computer scientists and domain scientists. We received nineteen answers from thirteen different laboratories. The answers about impact and challenges from these different populations provide a range of views. In addition, we posed the same set of questions to ChatGPT to sample more generalized views on the ethical application of AI for Science. The questions are listed in the appendix.

Analysis

Below is a summary of the information collected by the methods previously discussed. To rapidly derive findings, as well as an attempt to demonstrate a potential use case, ChatGPT [6] was used to perform an initial assessment of the gathered information which was then supplemented by human analysis. The comments presented below are not the opinion of the authors of this Think Piece, but the consolidated responses from survey participants. It is important to highlight that to strengthen the findings from this analysis, a broader survey should be performed.

Possible AI Impact on the National Lab Complex in the Next Five Years

Over the next five years, AI has the potential to significantly impact scientific research at national labs, though the extent of this transformation will depend on overcoming key obstacles. In the short term, AI is likely to automate routine tasks like data analysis, image classification, and experiment calibration, helping researchers focus on more complex problems. It could also accelerate discoveries in areas like materials science, cosmology, and energy by improving simulation accuracy and integrating large datasets from diverse fields. AI assistants, such as large language models (LLMs), may evolve from basic tools into more sophisticated aids capable of brainstorming and assisting with coding.

However, major challenges remain. The adoption of AI will be gradual due to leadership gaps, short-term funding structures, and a lack of sufficiently specialized datasets for training AI models in scientific contexts. Additionally, the transition from AI prototypes to fully functional, reliable tools is a complex and time-consuming process. Over-reliance on AI also risks undermining fundamental scientific skills, and concerns around data privacy, security, and bias persist. Despite these challenges, the next five years could see AI become more deeply integrated into scientific workflows, laying the foundation for more transformative changes beyond this period.

The integration of AI technologies at national laboratories is anticipated to transform the workforce significantly. While some roles, particularly those focused on routine tasks such as data analysis and experimental design, may diminish due to automation, new positions specializing in AI development, data curation, and ethical governance are expected to emerge. In addition, AI for business applications could also result in a significant shift of responsibilities (e.g., legal, procurement, etc.). Current employees will need to adapt through upskilling and reskilling to effectively collaborate with AI tools, which will enhance their work or free time for them to pursue alternative tasks. Though the pace of change may vary by field, the transition will require a strategic approach to workforce management, emphasizing the need for training and development to ensure employees can leverage AI's capabilities while maintaining a commitment to safety and ethical standards. Overall, while some jobs may be lost, AI is likely to create new opportunities and elevate the capabilities of the existing workforce.

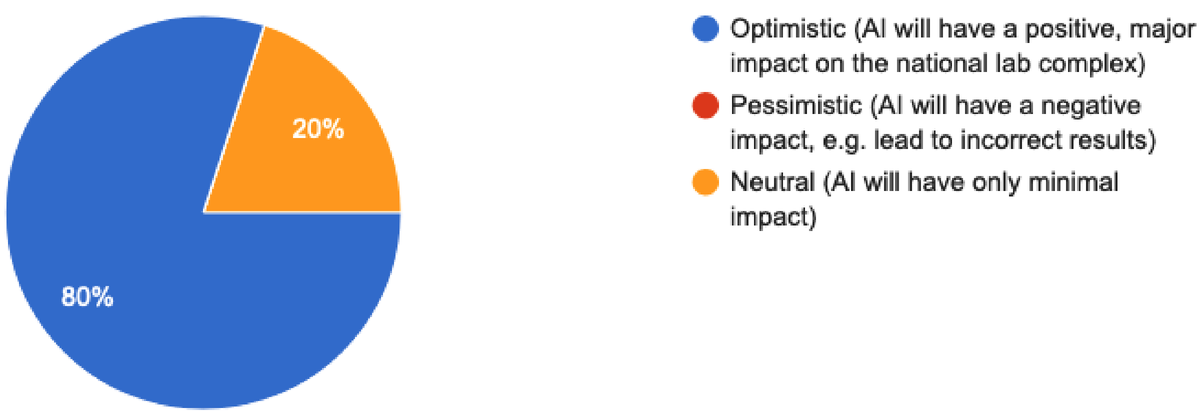

***Figure 3**: Q2 from the questionnaire: How do you think AI will change the National Labs in the next five years?*

Figure 3, above, depicts survey participant perspectives on the potential impact of AI on the national lab complex over the next five years. 80% of respondents indicated they believe AI will have a positive and major impact on the national lab complex. 20% indicated AI would have only a minimal impact on the national lab complex. And 0% of respondents indicated they believed AI would have a negative impact.

Collaborations Across Laboratories and Industry

A critical need for national laboratories to carve out a distinctive role in AI research and its application is emphasized, particularly in areas not pursued by private industry, such as foundational science and legacy data curation. While there are significant opportunities to develop new collaboration models with academia and industry, several challenges must be addressed. These include the fragmented nature of national laboratories' efforts, internal competition for funding, and difficulty retaining talent, especially given the higher salaries and focus available in the private sector. A successful AI initiative will require clear, ambitious goals—similar to the Manhattan Project or DOE's response to the COVID pandemic—a unified vision, strong central leadership, and effective governance to manage and coordinate efforts across multiple labs. Furthermore, there must be a focus on fostering a culture of collaboration, developing shared tools and infrastructure, and addressing challenges unique to scientific research, such as the need for explainable AI and the integration of curated scientific data. Agile project management, rapid prototyping, and partnerships with industry will be essential to ensure national laboratories remain competitive and make meaningful contributions in areas like climate change mitigation and national security.

The collaboration among national laboratories, industry, and academia presents significant opportunities, particularly in leveraging the vast amounts of data and computing resources available at the labs, as well as access to domain experts with experience in development and utilization of AI in support of the DOE mission. While the number of AI applications developed throughout the national laboratories continues to grow, these efforts are for the most part, individual contributions. The potential for collaboration across the national laboratories exists and these partnerships could facilitate advancements in AI research by creating shared educational materials, research initiatives, technology transfer programs, and talent exchanges, fostering innovation that addresses critical national interests such as clean energy and climate change. One example could be the development of a collaborative "National Laboratory AI Academy," focused on training researchers and scientists at the national laboratories on the use of AI that could offer both formal and informal AI training leveraging existing programs from across the individual laboratories. An additional example would be the use of Transfer Learning, as previously discussed, to accelerate the development of domain-specific ML models in cases where available datasets may be sparse.

However, challenges to collaboration exist, stemming primarily from differing operational paces and goals. While industry seeks rapid commercialization and profit, academia seeks educational opportunities, and national laboratories prioritize long-term scientific research, national security, and public welfare. Intellectual property conflicts, security concerns, and varying expectations regarding research speed can hinder effective collaboration. To navigate these complexities, both sides must establish clear communication, set shared objectives, and develop flexible partnership models that align their respective interests, ultimately enhancing the potential for impactful AI solutions.

Data Sharing and Curation

The national laboratory complex currently faces significant challenges in data sharing that hinder the effective development of impactful AI tools. Despite the foundational elements being in place, issues such as data ownership, proprietary formats, cybersecurity concerns, and institutional resistance complicate efforts for seamless data integration. To address these challenges, a comprehensive strategy is required, focusing on standardizing data formats, establishing robust governance frameworks, and building secure infrastructures for data sharing. This effort must also tackle cultural barriers that prioritize competition over collaboration and recognize that the data generated from taxpayer funding should be more accessible to promote collective scientific progress.

While initiatives like the Integrated Research Infrastructure (IRI) [7] and High-Performance Data Facility (HPDF) [8] signal progress, they alone are insufficient to overcome the existing hurdles. Major policy changes, such as those proposed by the National Science and Technology Council's Subcommittee on Open Science [9], significant funding, and a commitment to developing effective data management practices are essential for enabling a culture of openness. Moreover, leveraging task-specific AI models for data standardization and curation can enhance accessibility, although creating such models presents its own complexities. Building consensus among diverse stakeholders and fostering an environment conducive to collaboration will be vital for realizing the full potential of data-driven research. Ultimately, without a unified approach and shared commitment, the ability of the laboratory complex to harness data for advanced AI applications may remain limited.

Moreover, the questionnaire has highlighted a need for greater preparation in the area of data sharing. In particular, respondents did not feel confident in their current ability for sharing and/or curating large datasets for use outside of their immediate teams. This highlights the need for standardized data formats, assistance in establishing data repositories and training. It should not be assumed that domain scientists have the necessary knowledge to adequately share datasets for the purpose of AI/ML model development, and to accelerate this capability additional training and personnel are needed.

Figure 4, below, shows the perspectives of survey participants on the readiness of the national lab community to share data effectively. 50% of participants indicate they believe the national lab community is not currently ready to share data effectively. 35% indicated that readiness to share data depends on the specific research community. 10% indicated they believe the national lab community is not yet ready but is nearing readiness. And the smallest segment of respondents, at 5%, indicated they believe the community is already ready to share data effectively.

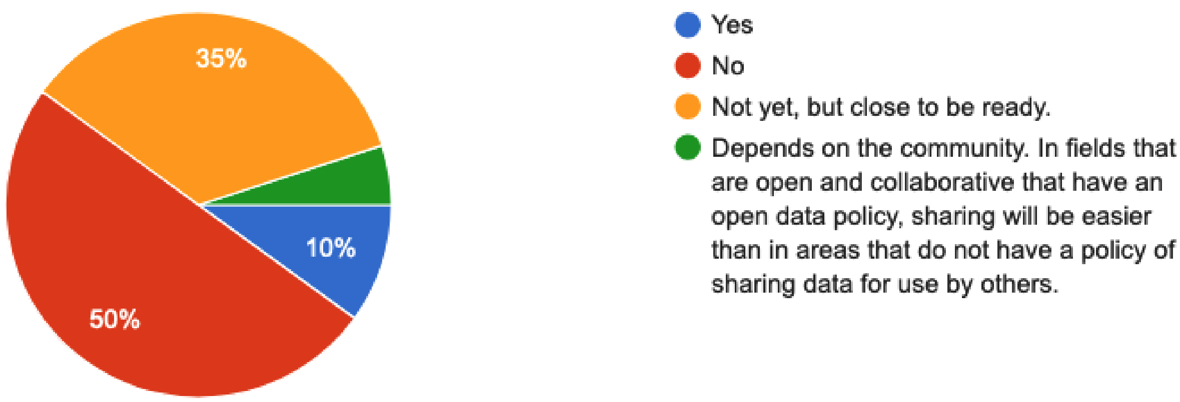

***Figure 4**: Q7 from the questionnaire: Excellent data and sharing data across the labs will be important to build the most impactful AI tools. Do you think the lab complex is ready for this?*

Ethical and Reliable Use of AI

Establishing guidelines and best practices for the ethical and responsible use of AI in scientific research is essential, particularly as AI tools become increasingly integral to the work at national labs and other research institutions. Guidelines will help ensure trust and accountability, fostering consistency across diverse labs and promoting transparent decision-making. They can also address critical issues such as bias detection and mitigation, sensitive data handling, and ethical AI design. With the rapid proliferation of AI tools, it is vital to have frameworks in place that not only guide researchers on the acceptable use of these technologies but also ensure the data generated adheres to ethical standards, thus protecting privacy and promoting fairness.

However, there are concerns regarding the feasibility of rapidly developing these resources, given the complexity and bureaucratic nature of organizations like the DOE. While best practices may be a more pragmatic approach, particularly for less complex AI applications, there is an urgent need for standardized methodologies that synchronize efforts across different scientific domains. This would allow researchers to learn from each other, share lessons, and establish guardrails to prevent erroneous results that could undermine the credibility of scientific findings. Ultimately, the aim should be to foster a collaborative environment where ethical considerations in AI use are taken seriously, ensuring that the advancement of AI for science aligns with both scientific integrity and societal values.

A Gedankenexperiment: Data Challenge Case Study[1]

To enable the full power of AI based on the immense data resources the national lab complex owns, the very first step is to collect, share, and curate the data across the complex. This is a major challenge that has to be overcome in many science areas and needs to involve both domain scientists and computer scientists. From our questionnaire, we found there is a concern about

1 A Gedankenexperiment (German for "thought experiment") is a concept used in philosophy, physics, and other disciplines where hypothetical scenarios are devised to explore the implications of a principle, theory, or idea. These experiments are conducted entirely in the imagination, rather than being physically executed.

our data readiness. When asked, *"Excellent data and sharing data across the labs will be important to build the most impactful AI tools. Do you think the lab complex is ready for this?"* more than 80% of the answers indicated we are not yet ready (see Figure 2, above).

To understand some of these challenges in more detail and to evaluate the readiness of the laboratories to share and curate data for AI purposes, we discuss a case study that on the surface may sound easy, but in detail will likely expose some of the difficulties we face. The question posed is simple: Is it possible to identify a scientific question of interest that is being addressed at multiple laboratories, collect and curate the data related to the study of this scientific question, and train a model in a manner that is on pace with practices existing in the industrial sector? As a matter of interest, this approach could be used on a scientific question that was "solved" through conventional (non-AI/ML) scientific study. Regardless of the topic of study, the following steps would be taken in the case study exploring the use of AI:

- All laboratories will be identified that own relevant data sets.
- Scientists from the laboratories will provide a brief description of the data they own, including size, format, metadata describing the data sets (this step will need to be carefully defined).
- Establish a means of sharing data between laboratories.
- Domain scientists and computer scientists will get together to homogenize the data to allow the usage of the data in future AI work. Here it is important to keep in mind how fast the field of AI moves and the agreed upon format should be flexible enough to anticipate changes in future approaches.

The case study would be carried out within a fixed timeframe (3-6 months) to follow the "schedule first" approach we have learned about during our visits to the laboratories.

The outcome of this case study would allow us to discuss some of the questions we have asked as part of our Think Piece after the case study has been carried out:

- Can the laboratory complex move fast to accomplish a well-defined task that includes more than three labs? The strict schedule defined at the start will be critical to answer this question.
- Can a collaboration across many laboratories find consensus for a well-defined task efficiently?
- Can a large collaboration agree upon data curation and sharing tasks?
- Are domain scientists prepared to curate data intended for training AI?

The case study would bring together domain and computational scientists, an important step to enable the best outcome for any AI initiative.

Summary

Integrating AI into the national labs presents a transformative opportunity for scientific advancement and national security. However, this also necessitates a well-defined strategic roadmap that aligns with national priorities and allows for adaptive planning. Leadership plays a crucial role in championing AI initiatives, fostering a culture of innovation, and creating inter-lab councils to coordinate efforts. Balancing innovation with risk management is essential, necessitating the establishment of ethics committees to oversee AI projects and ensure responsible use. Enhancing public engagement through transparency and educational outreach can build trust and inspire future generations. While the challenges are significant, embracing AI responsibly and enhancing the agility of the labs can lead to significant breakthroughs and efficient resource utilization. Acknowledging and addressing these barriers is vital for leveraging AI's potential for the greater good.

Even if several initiatives related to AI started in all the national labs, there are several significant barriers in fully leveraging AI advancements, including challenges related to cooperation, resources, and expertise. While DOE can likely enhance cooperation and resource allocation through incentives, attracting and retaining AI talent remains a critical issue, particularly as industry offers competitive salaries. Cultural resistance within the workforce, stemming from a predominant focus on traditional scientific methods, may also hinder AI integration. To address these challenges, initiatives such as creating "AI Catalysts" within teams could facilitate model development and experimentation. Additionally, fostering a culture of innovation, enhancing training programs—such as a National Laboratory AI Academy—standardizing data practices, and establishing clear ethical guidelines are essential steps toward overcoming bureaucratic inertia and fragmented data systems. Our analysis highlights the need to involve the workforce at all levels, to enable a smooth integration of AI in the day-to-day work. It will be beneficial to promote data sharing and address existing cultural and technical barriers between the National Labs. Ultimately, a coordinated approach that emphasizes flexibility, investment in AI expertise, and improved data management will be vital for the labs to effectively harness AI's potential for scientific advancement.

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Appendix A

In this appendix we provide the questions we sent to scientists and managers at 17 laboratories. We received 19 answers from 13 different laboratories. These answers informed part of our analysis section.

1. Please provide your name, email, and position (including a very brief statement about your interests regarding AI, e.g. scientific, leadership role).
2. We have seen extremely fast progress in AI over the last couple of years. How do you think AI will change the National Labs in the next five years?
    a. Optimistic (AI will have a positive, major impact on the national lab complex)
    b. Pessimistic (AI will have a negative impact, e.g. lead to incorrect results)
    c. Neutral (AI will have only minimal impact)
3. Given your answer to the previous question, please elaborate on your choice and describe your vision for the impact in the next five years briefly.
4. The fast pace of AI developments is driven currently by industry. National labs usually do not move at this pace and strong collaborations between many labs in the "Manhattan project" spirit is likely needed to keep up. The national lab complex has not seen many projects where more than 2-3 labs closely collaborate in recent years. The Exascale Computing Project (ECP) is an exception, however, most of the code base that went into the project already existed, so it was somewhat easier to get a good start. Besides funding, what do you think is needed to pull together a broad and strong collaboration that can be impactful in this fast-moving field across the labs?
5. Do you think the workforce at the national labs will change and be impacted by AI? For example, will some jobs disappear, will different, new job categories be established?
6. Connecting to industry seems crucial for a range of reasons (resources, fast pace of the field, etc.). We have two questions:
    a. How do you envision the labs will build the connection and what would the connections entail?
    b. What are the challenges given that industry might have different goals than the national labs?
7. Excellent data and sharing data across the labs will be important to build the most impactful AI tools. Do you think the lab complex is ready for this?
    a. Yes
    b. No
    c. Not yet, but close to be ready

d. Other

8. If your answer to the previous question was “no” or “not yet”, how do you envision this can be accomplished?
9. Ethical and responsible use of AI tools and of data will be crucial in particular for AI for Science. Do you think we need to establish guidelines and best practices across the labs and other research institutions? Please elaborate.
10. Do you see major barriers to enable the lab complex to take full advantage of the AI developments?
    a. Yes
    b. No
11. If your answer to the previous question was yes, please elaborate on what you think the barriers are and how/if they can be overcome.
12. Do you have any further thoughts you would like to share with us?

Our OSELP Learning Journey about Diversity, Equity, Inclusion, and Accessibility at the National Laboratories

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Bottom Line Up Front

During the Oppenheimer Science and Energy Leadership Program, we explored the different ways in which the National Laboratories implement programs related to Diversity, Equity, Inclusion, and Accessibility (DEIA). Our synthesis of these experiences highlighted some common areas of emphasis: the importance of Lab values, a sense of belonging in the workplace, and a focus on outcomes that increase DEIA at the Labs.

Our Learning Journey

Lab Visits

Throughout the year of our visits to all 17 national laboratories, the themes of culture and workforce challenges were discussed by the presenters and by the cohort. For our national laboratories to remain premier institutions for innovation and impact, we must have the best talent assembled into effective teams. The nature of the problems being pursued in science, technology, and national security continue to evolve to require more and more integration across diverse technical specialties. Each of the labs recognize that Diversity, Equity, Inclusion, and Accessibility (DEIA) is vital to achieving the highest level of accomplishment from the current workforce, and all the more to foster the pipeline of talent for future success.

While each lab described similar workforce needs, the labs exist in significantly distinct environments regarding the breadth of their portfolio, demographics of their workforce and community, and the cultural and political climate of their geographic location.

Three common themes discussed across the labs were recruiting, retention, and belonging in the face of major changes in the workforce in recent years. Most labs reported large increases in staff size in the last decade, while also managing many retirements. Many labs are facing a workforce with 50% or more of their staff having been at the lab for 5 years or less. The post-COVID shift toward hybrid staff and the associated fluidity of work modes are also challenging lab culture and staff retention. Each of these themes requires that DEIA be addressed as a strength of the lab cultures.

And yet, DEIA is a highly charged topic for many and some areas in the United States have restricted DEIA programs in public institutions. Restrictions on DEIA programs are likely to evolve significantly in the current national political transition. We recognize that each prior cohort has also addressed one or more aspects of DEIA and workforce development. Indeed, we appreciate the fact that we could learn from those prior think pieces and OLN interactions in addition to our own specific efforts to understand the issues in the current context.

Conversations with Lab Leaders

We spoke with a selection of leaders from across the system and gained additional insight after our Lab visits.

National Laboratory Chief Diversity Officers

Team members from this group attended the National Laboratory Chief Diversity Officers (NLCDO) meeting on October 19, 2024, to share our progress on this Think Piece. We engaged the NLCDO for feedback on our topic and received suggestions on moving forward, notably to highlight resources and opportunities rather than identifying best practices. We have shared this white paper with that group for their awareness.

Ames National Laboratory

Ames Lab has already faced the challenge of conflicting federal and state guidance ahead of other labs because the state of Iowa implemented state legislation to prohibit DEIA programs at state institutions. Ames Lab had to adapt and find creative ways to build a culture of welcoming and belonging that achieves the same outcome of DEIA initiatives at other labs. The specific actions they've taken include:

- Rolled out a culture climate survey with 53% participation which informed their strategies to build a welcoming and belonging culture.
- Pursuing a series of activities to bring their lab community together such as annual fall picnic where all employees and their families are invited and by complementing their annual golf tournament with a corresponding minigolf tournament.
- Building an extensive support network providing mentorship for everyone, and coaching and leadership development opportunities.
- Making resources available for everyone for soft skills and professional development.

Brookhaven National Laboratory

Brookhaven National Lab leadership reiterated their commitment to DEIA principles and their approach to implementation, as explained below:

- **Redefining DEIA's Value**: DEIA should be a mission-critical aspect, not a "nice to have," and must be relevant and meaningful to everyone across the organization. The focus is on shifting from addressing DEIA as a compliance task to seeing it as a strategic strength that enables productivity, success, and safety.
- **Operationalizing DEIA**: DEIA should be infused into daily operations, moving from isolated office-led initiatives to a cultural approach that everyone participates in and supports. Leaders at all levels need to see and communicate its connection to productivity, making it part of the organization's fabric.

- **Addressing Internal Barriers**: Organizational layers or "blocks" can inhibit progress and communication, creating a sense of "permafrost." Understanding these barriers, addressing microaggressions, and rethinking training are essential to improve inclusivity across levels.
- **Engagement Beyond Traditional Approaches**: Moving past traditional approaches, such as surface-level training, to foster impactful engagement is critical. The goal is to engage not just "the choir" but reach the entire organization by providing relatable, impactful examples that resonate with both leaders and individual contributors.

Idaho National Laboratory

Conversations with Idaho National Laboratory leaders focused on the recent DEIA survey sent to many of the Labs through the NLCDO. The survey is one way to assess outcomes across the labs with consistent metrics. In an earlier approach to this Think Piece, we had considered inclusion of "anecdata" to illustrate some of our learnings. However, this approach did not resonate during our discussion with INL because it is not necessarily representative of broader sentiment at the Labs. We did learn about some of the results from the survey at INL, however a deeper dive will only be possible once the data are released. In terms of DEIA initiatives within INL itself, there are five leadership councils, raising the voices of different groups from women to LGBTQ communities, to veterans & people with disabilities. INL has also implemented a lab-wide inclusivity strategy that has embedded inclusivity advocates across the organization at different levels.

Lawrence Berkeley National Laboratory

Discussions with Berkeley Lab leadership focused on achieving the desired outcomes of DEIA programs, even when those programs are under attack. Much of this discussion centered around the business need for increased diversity, equity, inclusion, and accessibility. The workforce needed for continued leadership in DOE mission areas will be more challenging to recruit and retain. As the United States' birth rate declines and the pool of eligible talent is constrained by programmatic needs for STEM experience and national/research security policies, the Labs will be competing for the best talent. Hiring from countries with strong STEM pipelines, such as China and India, is likely to become limited as those countries seek to prevent brain drain and keep their own talent. These factors highlight the need for casting the widest net for talent within the United States and retaining employees for the long term. DEIA principles are central to achieving that goal, even under circumstances where DEIA programs are restricted.

By focusing on the desired outcomes (e.g. diverse workforce, inclusive workplace), the same effect can be achieved even if DEIA programs are dismantled. One way of realizing these outcomes is implementing activities that support everyone and that are shown to increase diversity, equity, inclusion, and accessibility. For example, mentoring programs are available to everyone but can increase equity by lowering barriers for underrepresented groups in leadership positions. Programs that have the same outcomes as specific DEIA activities but offer benefits to all are important to continuing progress towards a more diverse workforce and inclusive workplace.

Discussions with Mentors

As part of our OSELP activities, we spoke with two mentors to the program and had two very different conversations. These conversations offered differing views of past DEIA efforts at the National Labs.

Mentor 1 shared her own journey and highlighted how increasing diversity of the workforce needs to be managed, especially in leadership. When she joined her Lab, the then Lab Director anticipated an increase of women in the workforce and focused efforts on recruitment and retention of women. He implemented a series of actions to evaluate women and minorities at each level periodically, intentionally give women broad experience (e.g. lateral positions) to prepare them to be promoted, and coach them to be successful for their various roles. After this initial push, there were almost 2 decades of continued effort, which led to a whole cohort of competent women in senior leadership positions. She highlighted that the top-level leadership needs to believe it and manage it proactively for the strategy to be implemented and successful.

Mentor 2 expressed that the National Labs are measured by their scientific accomplishments, highlighting the number of Nobel prizes associated with the National Lab system. He also stated that he felt pressured to manage people from diverse backgrounds in a previous position, feeling that they were not selected on merit. While he remained circumspect about the value of DEIA efforts for the National Labs' missions, the conversation underscored the sensitivities and resistance that DEIA initiatives can encounter. This interaction highlighted the importance of fostering psychological safety and encouraging constructive criticism when engaging in discussions about potentially controversial topics.

Think Piece Journey and Adaptation

This team began the OSELP experience interested in how individuals, including line managers not in leadership positions, can support DEIA goals while adding value to their work and the effectiveness of their teams. Specifically, we have looked for the practices that show how DEIA enhances work at the labs rather than practices that cause DEIA to be perceived as a burden.
While we were developing our Think Piece, we didn't lose sight of this core interest. This Think Piece evolved as we visited labs, spoke with Lab leaders, and had discussions with mentors. These experiences expanded our initial understanding of DEIA policies and programs, while highlighting the unique environment in which each Lab operates. Following the 2024 presidential election, anticipated actions to terminate DEIA programs at the federal agency level refined our focus to understanding how the Labs can achieve many of the same outcomes from DEIA programs but through alternative activities.

Synthesis

A workforce that draws from the full diversity of the American people is better able to serve the nation. For the DOE National Lab ecosystem to meet the urgent DOE mission of conducting research and development that addresses national priorities in energy, climate, the environment, national security, and health, the value proposition of diversity, equity, inclusion, and accessibility (DEIA) is clear. Diverse teams lead to better, faster science and technology output. OSELP Cohort 7 has the unique experience of witnessing a fundamental shift in the federal government's acceptance of DEIA programs, transitioning from advocacy to now opposition. Therefore, the need to reframe the principles and machinery of DEIA in the National Lab system to preserve gains and ensure inclusive workplaces is crucial. In each of our 17 DOE National Lab visits, though the jewels of this ecosystem may be the lasers, light sources or laureates, the foundational ability to meet the science and technology challenges of our nation depends on the people that perform the work. From our Lab visits and follow-on conversations, we distilled our learning into four themes to consider. Table 1 (at the end of this document) lists some DEIA-related activities, outputs, external factors, and outcomes summarized from our learnings.

Outcomes

DEIA programs result in many activities across the Labs that range from the one-time or one-off event (e.g. seminars, training courses) to those that require on-going commitment from employees (e.g. Employee Resource Groups, DEIA councils). While there are many ways that staff can engage in DEIA programs, these programs must be meaningful and advance the overall goals for the organization. Here, an understanding of the desired outcomes of these programs is crucial to successfully achieving those goals.

Externalities

While DEIA programs aim to increase representation of underrepresented groups across each National Laboratory, there are externalities that influence the success of these programs. The 17 National Laboratories differ in mission (constraining the talent pool), location (different demographic compositions of talent pools), security requirements (requirements for U.S. citizens that can obtain security clearances), and local culture and laws (restricting modalities of DEIA programs). Goals and related outcomes need to be established within the context of an individual lab and there must be continued evaluation of the outcomes. One-size-fits-all policies are not desirable, instead policies and programs must be focused on the individual needs of Labs or their sub-organizations.

Political Climate

If government policies prohibit some modalities of DEIA programs, National Laboratories can consider adjusting their approach to align with restrictions while maintain core values of respect and belonging. Shifting focus to universal initiatives that emphasize merit-based recruitment from a broad candidate pool, transparent hiring practices that focus on workplace skills, and professional development accessible to all employees could provide a way forward, fostering a collaborative, welcoming, and respectful culture without explicitly referencing DEIA. One example of a broad opportunity that supports DEIA outcomes is mentoring. Providing all employees access to mentorship supports everyone, but also increases diversity in management and leadership by lowering barriers to advancement. When DEIA programs need to be less visible, these types of activities can still lead to desired outcomes.

Evaluation

One of the important points from our experiences is the need to evaluate the effectiveness of programs towards meeting desired outcomes. There is no end to activities to develop an inclusive culture but the utility of activities to achieve desired outcomes must be assessed. Evaluation should also consider unintended consequences or external factors like workforce trends that might affect progress. Regularly reviewing data—such as recruitment numbers, diversity metrics, and participation rates for programs and surveys—alongside external influences allow Labs to catch any misalignment between expectations and results. This is ongoing across the Labs through culture surveys, the recent ERG survey from the NLDC, and other local evaluations. Timely adjustments to strategies and activities can be made, ensuring outputs stay on track toward intended outcomes. A robust, adaptable evaluation framework also aligns well with the Labs' culture of innovation and data-driven decision-making.

Conclusion

During our year participating in OSELP, our individual interest and perceptions of DEIA programs have expanded. During our visit to Ames Lab early in the program, we were introduced to the challenges a Lab faces when federal sponsors require DEIA action and state laws prohibit DEIA programs. This experience, along with our other lab visits, led us to think about these programs with more nuance for each Lab's particular needs. DEIA cannot be a prescribed set of policies, activities and outcomes for the Labs, it must be integrated and responsive to the values and needs of an individual Lab.

We also experienced the heightened emotions and sensitivities around this topic. Because of strong political forces for and against DEIA programs, the Labs face significant risks in implementing these programs. We pivoted our plans for this Think Piece to respect the variety of opinions and sensitivities about DEIA. We gained experience in the issues that confront Lab leaders on a regular basis and may be more salient as the administration changes in 2025.

We remain advocates for DEIA outcomes in our workplaces and will bring this forward with us in our leadership journeys. However, we are more knowledgeable about the implementation of DEIA policies, programs, and activities considering unique Lab needs and sensitivities. The politics and policies may shift rapidly, and the Labs will need to be agile in their approaches. Our OSELP journey has better prepared us to consider the ways in which DEIA principles and outcomes can be achieved to support the National Labs' missions and workforce, while adapting to shifting federal, state, and local laws and policies.

Table 1: Approaches, Activities, Externalities, Outputs, and Outcomes

Approach	Activities	Externalities	Outputs	Outcomes
Mentoring	Structured Mentoring: Pair experienced staff with early-career employees, focusing on underrepresented groups. Mentor Training: Train mentors on effective practices and cultural awareness. Networking Opportunities: Facilitate mentor-mentee networking events. Career Development Resources: Provide career development workshops and resources.	External Factors: Organizational changes funding availability, workload demands affecting participation. Internal Factors: Resistance to formal mentoring, time constraints for mentors, varying commitment levels.	Quantitative: Mentor-mentee pairs established, training sessions conducted, participation rates in events, comparison of history of program participation to awards and promotions. Qualitative: Feedback on program effectiveness, mentee satisfaction, mentor engagement levels.	Short-Term: Enhanced job satisfaction, increased engagement, skill development among mentees, improved retention rates. Long-Term: Career advancement for mentees, development of a diverse leadership pipeline, more inclusive organizational culture.
Focused Themes and Values	Emphasis and training on: Emotional Intelligence Inclusion Psychological Safety Respect	Internal Factors: Limited funding, workload demands affecting scheduling and full participation, potential resistance and commitment level, supervisors may not be prepared for resistance.	Qualitative: Helps Staff further embed and practice values and behaviors that foster a respectful work environment, rubrics for assessing staff alignment to values.	Short- and Long-Term: Clarified expectations of behavior in the lab culture, increased self-awareness about engagement, more voices are heard, increased productivity and team collaboration.
Recruitment	Strategic Partnerships with HBCUs, HSIs, TCUs, and professional diversity organizations (e.g., NSBE, SHPE) in addition to the historic networks of strategic university and professional societies that labs have long fostered. Use blind recruitment, diverse interview panels, and host career fairs targeting	External Factors: Educational pipeline limitations, job market competition, and changes in DEI policy impact recruitment success. Internal Factors: Possible workforce resistance to diversity efforts and persistence of unconscious bias.	Quantitative: Diverse hires, partnerships, and event engagement. Qualitative: Employee feedback on inclusiveness, cultural competency improvements, and recruitment effectiveness.	Short-Term: Boosted diversity in hires, stronger inclusion reputation. Long-Term: Leadership diversity, inclusive culture, and STEM pipeline growth, access to the best talent across the nation, beyond a priori networks.

	underrepresented groups. Offer internships and fellowships for diverse groups (e.g., GEM Fellowship).			
Rotational Assignments	Offer opportunities to staff for have limited time assignments in leadership or management positions	Internal Factors: Availability of positions for rotations, salary differential between positions, training for leadership, management, or other types of work, opportunity for advancement following rotation	Quantitative: Number of staff rotations, number of available positions, number of promotions resulting from opportunities. Qualitative: Employee feedback on experience, increased participation from a wider group of staff.	Short- and Long-Term: Lowered barriers to advancement, enhanced understanding of Lab mission and operations.
Employee Resource Groups (ERGs)	Establish Employee Resource Groups or other avenues to connect employees	Internal Factors: size and diversity of workforce, geographic populations, geographic culture, Lab culture, reliance on volunteerism, impact can be unclear.	Qualitative: Safe space of representation among the constituency, interface with management across the lab for advocacy, connection of constituents to mentoring and other leadership development programs of the lab, opportunity for allies to be together with the constituency, providing educational opportunities about allyship, outreach to community outside the lab (e.g., outreach engagement, scholarships, internships), interface with analogous ERGs at other national labs.	Short- and Long-Term: Sense of belonging at the Lab, increased retention of talent, increasing the breadth of talent pipeline.

Enabling a Vibrant Management and Leadership Culture Across the National Lab Complex

Authors: Christina Wildfire (NETL), Kaila Raby (SNL), Yarom Polsky (ORNL), David Micheletti (PPPL), Christopher Tassone (SLAC), Jim Serafin (ORNL)

Overview

Leadership at all levels within the National Lab system is an extraordinary opportunity to bring mission-driven staff and goals together. As members of OSELP Cohort 7, we discovered that nearly all labs are undergoing a major transition of staff with over 50% of the workforce having been with their home institution for less than 5 years. More than ever, leading teams within the lab complex involves a fluid range of responsibilities: conventional elements of steering a top tier S&T organization; rapidly addressing special elements such as DOE mission priorities and operational requirements (especially during times of government transition).

The combination of influx of new employees plus attrition of long-term staff introduces challenges for transmitting and preserving institutional knowledge and expertise, educating new staff on DOE mission goals and requirements, maintaining the culture of the laboratory, and aligning on what success and impact look like. We wanted to bring awareness of this common dynamic across the lab complex and study how the labs are approaching this change. This creates a valuable opportunity to highlight what we can do together to give all leaders the best chance to excel and support their teams in this unique environment.

Surveying across the OLN and Lab HR To help us bring different perspectives and best practices to our home labs, we started with a survey of the OSELP Leadership Network (OLN) to understand previous and current practices at the various labs. We also interviewed HR career development staff, whose insights and hard work represent the frontline of how leaders grow within the lab complex.

We ensured that the survey and interviews spanned single program, multi-program, applied, research and NNSA labs. We set out to baseline the leadership culture, roles/responsibilities, and training across the labs. We explored the types of training, how labs approach the pathway to leadership, time allocation of managers for their staff, and support structures for our leaders.

We were encouraged to learn that many labs are developing and rolling out inspiring leadership and management programs and are taking a harder look at management culture. We also identified a few potential management practices that are not currently being addressed widely by the labs.

“Leadership” > “Management” – Early interactions between OSELP colleagues indicated that most National Laboratories had different approaches for setting expectations and developing skills for the leaders of their laboratories. These differences were especially pronounced for frontline management, the level of management that is setting the tempo for laboratory staff. A recent Harvard Business Review article emphasized the importance of frontline managers stating, "Frontline managers account for 50-60% of a company's management ranks and directly supervise as much as 80% of the workforce."[1] These managers are responsible for managing employee performance and providing constructive feedback; solving problems in day-to-day operations, and they serve as a crucial link between upper management and employees for effective communication of strategic visions and initiatives.[2] With all 17 National Labs represented in the cohort, we saw the OSELP program as a unique opportunity to obtain data and perspective on the approaches to management and leadership across the National Laboratory complex.

We also want to differentiate management vs leadership, with management for the context of this discussion, involving a focus on oversight and compliance and leadership involving how managers set direction, engage their staff, and influence culture. We have found that all the labs had thorough compliance training, from legal training (e.g. harassment, discrimination to protected classes) to laboratory policies. **What we focus on here is the different labs' expectations and preparedness strategies for their managers as leaders.** This fostering of leadership qualities to frontline managers improves retention of staff as well as boosts morale and a healthy culture of an organization.[3]

Survey & Results

A key component of this study was a survey sent to the OLN. The OLN is comprised of individuals from every National Lab, spans operations, research, executive management, and includes former lab employees. The survey posed 22 questions covering responsibilities, training, support, and preparedness for management at each National Lab. A selection of the survey question and results are available in Appendix A and the complete data is available upon request.

Key results of the survey

1. More than 50% of respondents felt insufficient time was allocated for managerial duties.
2. More than 50% indicated that their organizations lacked defined roles and responsibilities for managers.
3. 44% felt initially unprepared to be a manager with 71% indicating their lab did not have a defined professional development strategy for employees.

The survey results and interviews revealed considerable inconsistency and, in many cases, a perceived deficiency of management development and support throughout the labs. Interviews

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with HR staff indicated significant action being taken by most labs on item 3. While a few labs were taking in-dept actions on all the key point, there was far less activity for items 1 and 2. The results suggest that there is an opportunity to improve the consistency and quality of preparation for current and future leaders.

1. Time Allocation for People Management

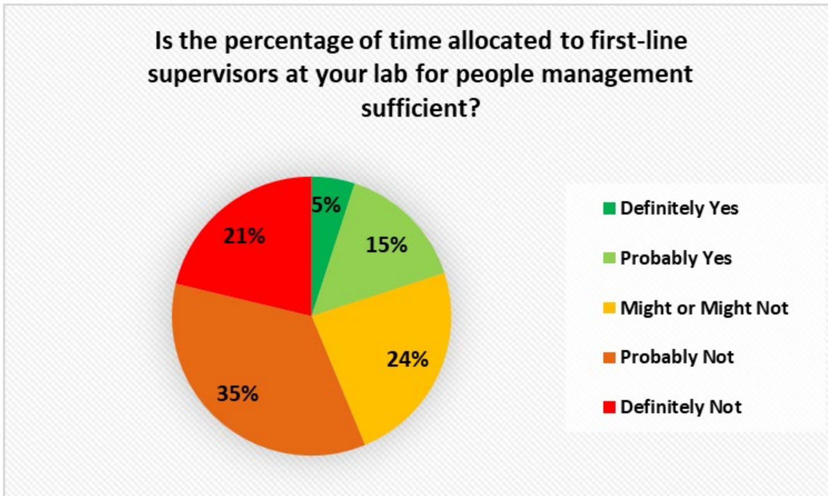


Figure 1: OLN survey results for sufficient time allocation for frontline managers varying from definitely not enough to definitely enough.

Manager and staff interaction is one of the largest factors in how staff feel about their jobs and the lab. It is critical that staff feel that their managers are vested in their performance and development. The survey results found that having dedicated charge time for frontline management varied from 0% to 100% among the 17 labs surveyed, a huge differential. It is reiterated that half of the survey respondents viewed time allocation for people management to be insufficient. While there may not be a standard percentage that is ideal within or across laboratories, and while there may be questions of whether the funding support comes through overhead or projects, the perception of no or insufficient dedicated time to devote to staff was viewed as a problem. Manager engagement and support often influence staff job satisfaction and the performance of an organization.

The majority of survey respondents also indicated that time allocated for frontline supervisors for people management was up to the individual to set at their lab. This lack of clarity is likely to produce inconsistent performance and leadership. Although financially it may not matter (as funds may come from the same projects), the perception by frontline manager is that they must choose between their customers (who they bill for their time) and engaging with their staff. This feeling that managers cannot dedicate enough time to their staff reinforces a compliance-based approach to managing people and does not leave time for managers to engage in optional training to grow their skills. By allotting appropriate time and more clearly defining the expectations for the role (next section) there is a greater likelihood of driving the desired behavior and improving leadership quality. Providing clearer guidance and adequate support can significantly enhance the retention of managers and their teams, as they are more likely to stay when they feel valued and supported.

2. Clear Roles and Responsibilities

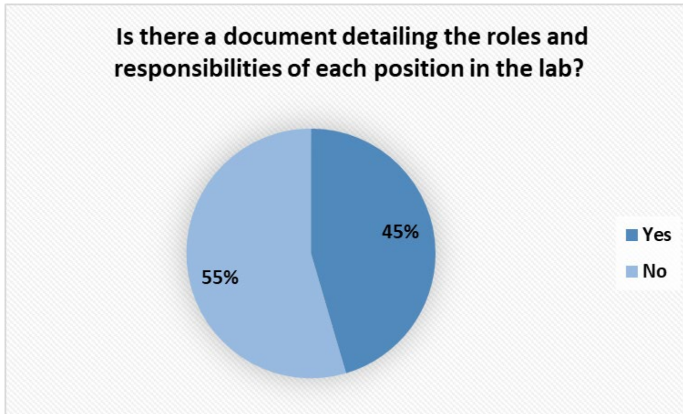


Figure 2: Survey result from 70 OLN members across the labs on detailed roles and responsibility documents.

Clearly defined roles and responsibilities (R&Rs) are essential to high-functioning organizations because they establish fundamental expectations for management and leadership. Our findings revealed considerable inconsistencies within a lab regarding R&R definition and awareness. Some organizations had defined roles, but many people were unaware of them or felt they did not provide enough clarity on authority or responsibilities. Even when formal R&Rs exist, they may not be broadly understood, or adopted. Although it can be a challenging task, defining consistent roles and responsibilities within an organization is crucial for better performance, accountability, and enhancing teamwork and collaboration. Clearly defining responsibilities for a given role like frontline managers can also help prevent overburdening individuals.

3. Unpreparedness for Being a Manager

Figure 3: Survey results indicating lack of communication or existence of a defined professional development strategy for employees.

The remaining finding (3) relate to lack of training, coaching, and providing a learning environment for new managers and for staff to become managers. Although the survey participants indicated that they did not have support in their journey to become managers, we were encouraged to find in our interviews that many labs are rallying around their new managers and providing a variety of support and training. The survey did not specifically ask about new and upcoming leadership development programs now being implemented at several labs. However, through our lab visits and additional conversations (Ames, Argonne, Fermi, INL, J-Lab, NREL, NETL, LLNL, and Sandia), we learned that many labs have or are creating exciting opportunities (this may not be a complete list as we did not discuss this with all labs). This Think Piece gave us a unique opportunity to document approaches and ideas from the labs that can be used more widely across the lab system. Although there are multiple working groups across the labs including the directors, COOs, TCOs, etc., the HR career development staff rarely interact across labs. By providing documented programs, practices, and connecting staff to one another we can improve our home institutions resources and training opportunities for our managers.

Inspirational Findings on Leadership Development Programs: Through our interviews we identified several best practices that are common across these programs:

- Forming cohorts to build peer-to-peer support networks that are both local and “global” (cross-functional areas across the lab, e.g. research to finance).
- Extending training focus from compliance to leadership development
- Utilizing SMEs to deliver compliance training to build personal connections and ensure that employees know who to turn to for guidance
- Selecting appropriate learning media (online, virtual, in person) and avoiding hybrid formats
- Making leadership training mandatory, with a graduated approach to timing that emphasizes key management capabilities early, and leadership development later
- Providing self-assessments and tailored trainings to address targeted development areas
- Making coaching available to frontline managers
- Ensuring accountability by tying performance metrics to roles & responsibilities
- Using diverse metrics to judge effectiveness, including HR complaints, anonymous self-assessments, manager-of-manager surveys, culture surveys (direct management portions)
- Ensuring consistency across the lab, mission area/directorate, and mission / mission-support areas
- Utilizing simulation-based management scenarios for to let aspiring managers practice typical management situations and provide follow on training recommendations

An Optimistic Conclusion

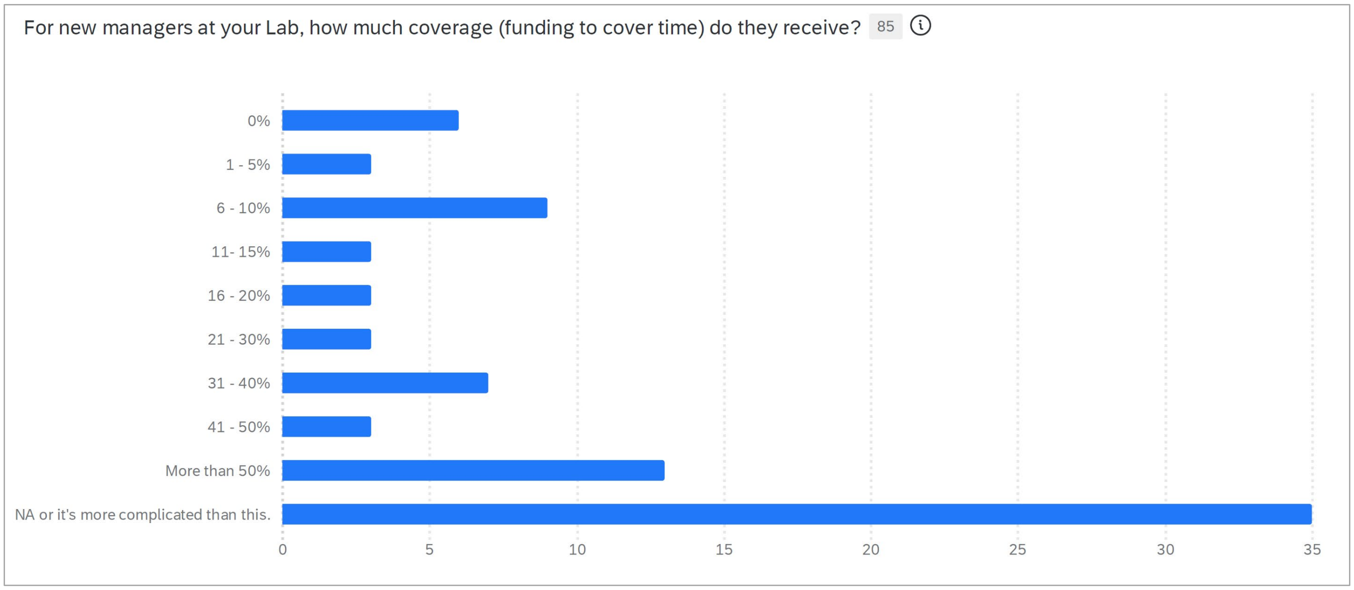
We recognize that the labs are facing a unique moment as lab “frontline leadership” undergoes rapid change and evolution. Frontline leaders are key to a healthy culture – they represent, and hopefully emulate, lab values to staff. This has direct influence on lab success: An engaged and aligned staff can move with speed and purpose to maximize the lab's mission and goals, inspiring all of us to bring our best.

Throughout our year of site visits, surveys, and interviews, we found 3 key takeaways for leadership and management training for managers: time allocation, defined roles and responsibilities, and unpreparedness for the role and growth within the organization. We feel it is best to invest in the frontline management due to their tremendous impact on the organization. While there are still improvements to be made, we came away feeling encouraged by the leadership and HR staff that has repeatedly emphasized the fact that people are the labs greatest asset. This emphasis is seen with the new programs and initiatives being brought up across the complex and could benefit from greater awareness and collaboration on solutions. We encourage our colleagues across the lab complex to reach out to each other to share best practices, tools and lessons learned.

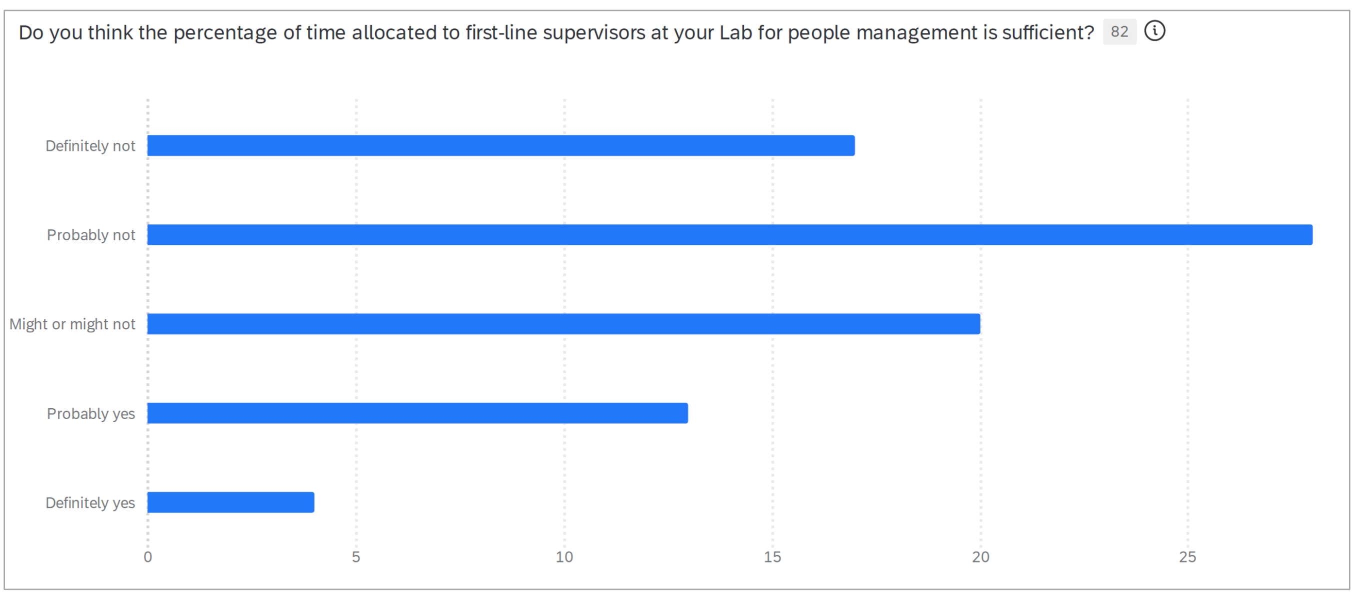
Appendix A – Survey Results

(all x-axis values are number of replies)

1. Percentage of time allotted for frontline manager duties.

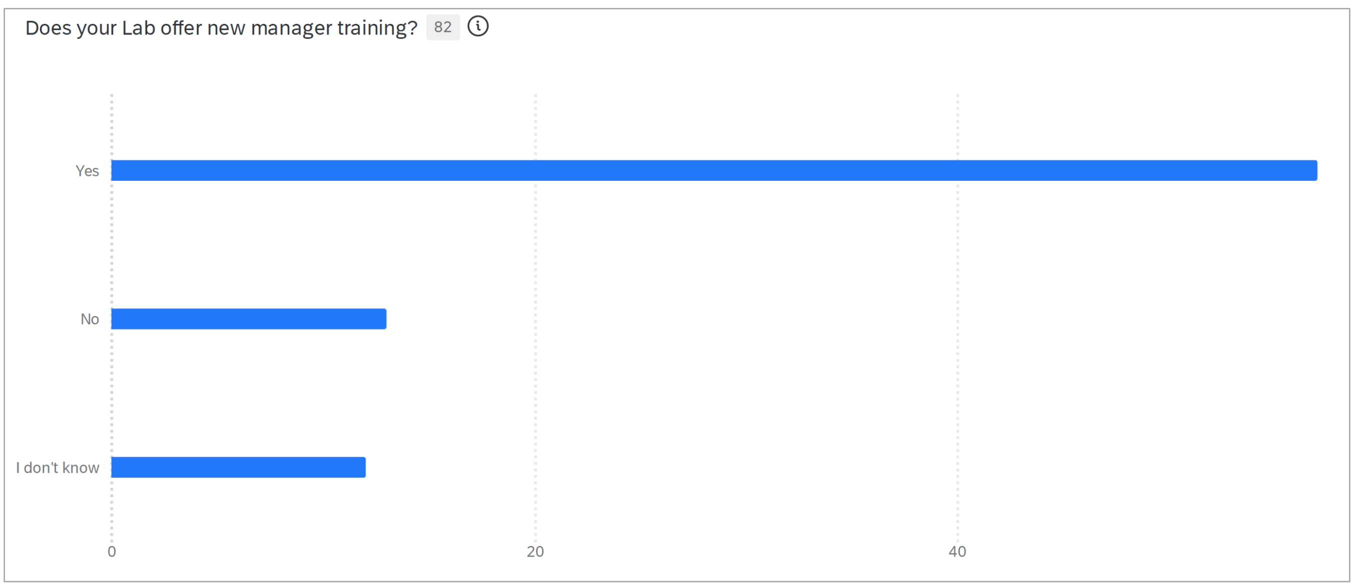


2. Adequacy of time allocated for frontline management.

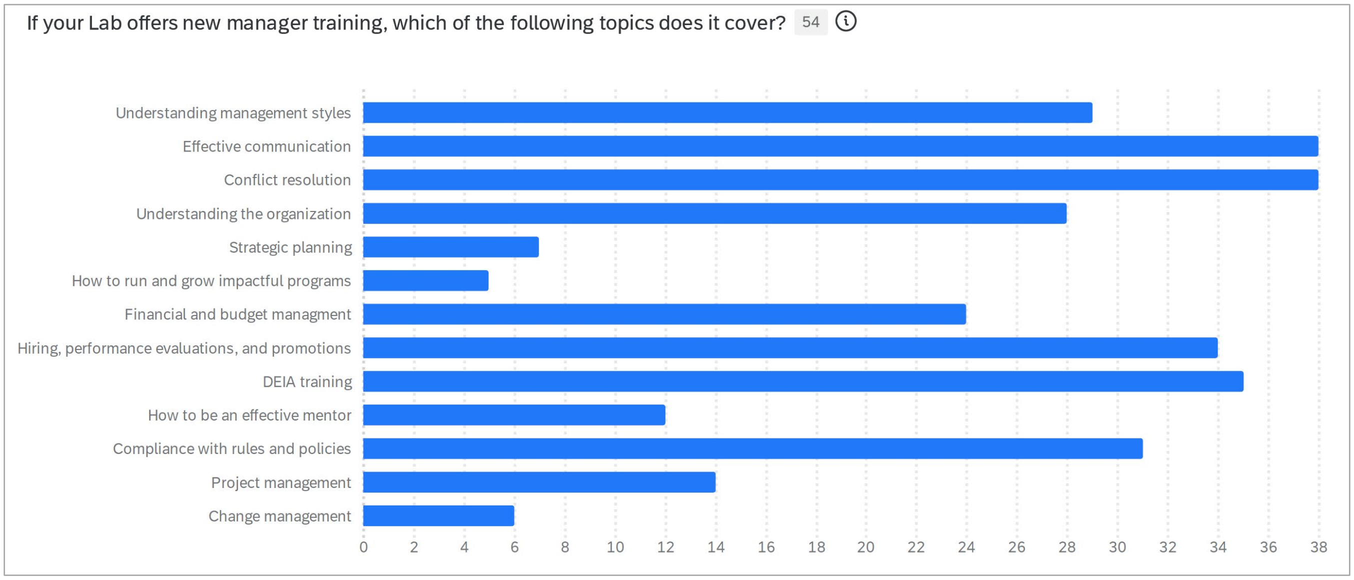


3. Determination of managerial time allocation.

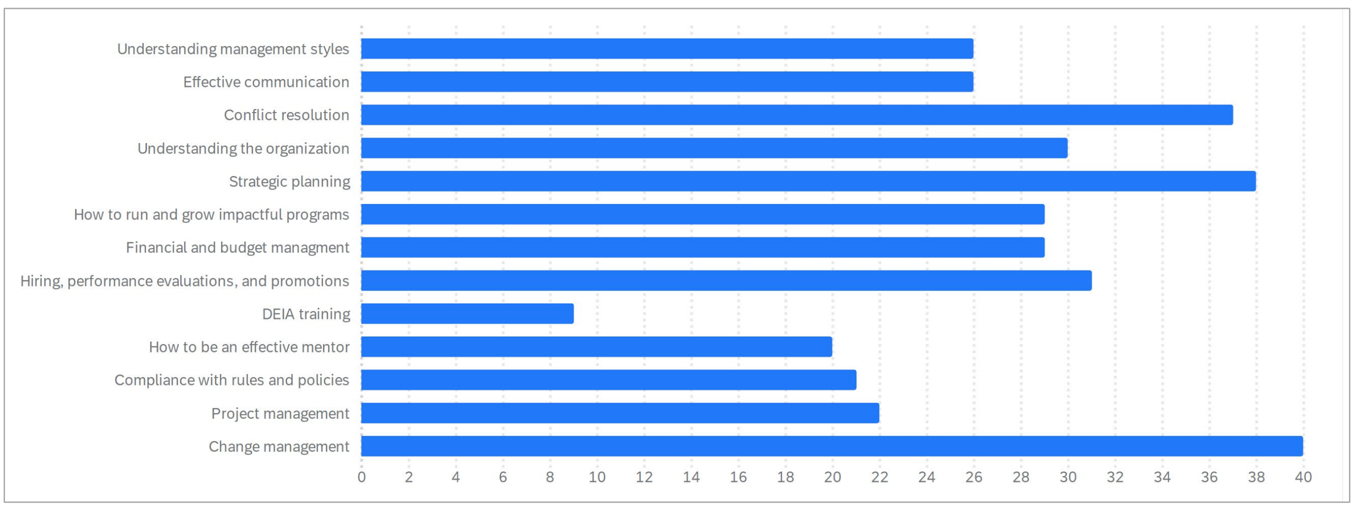
4. Existence of new manager training.



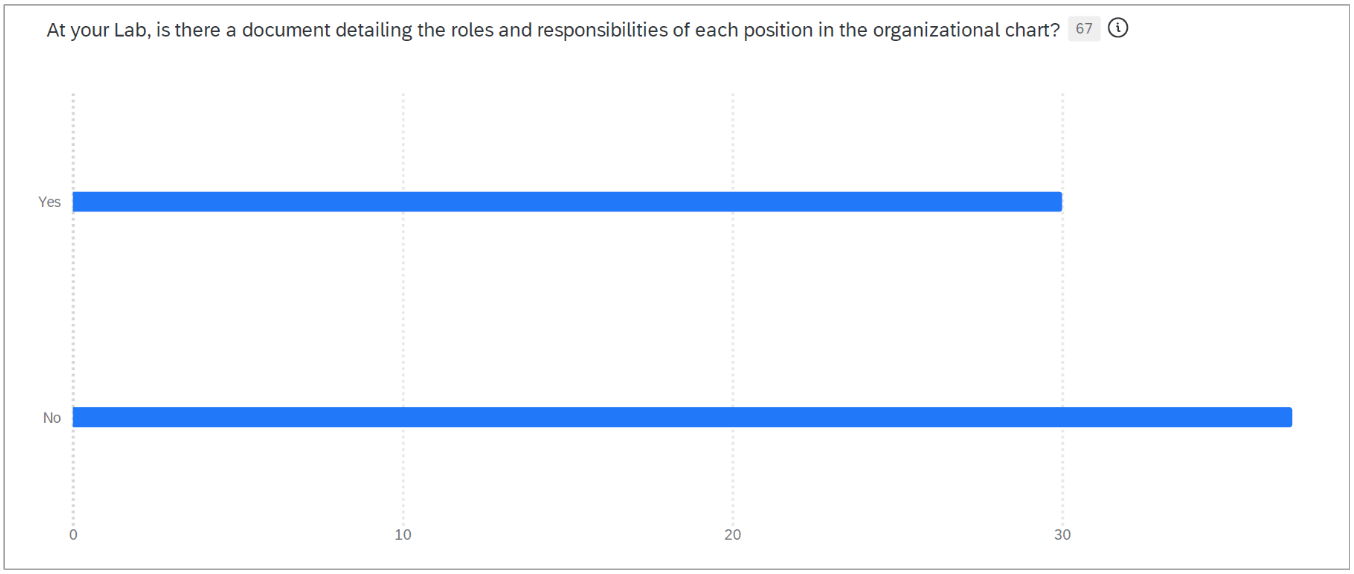
5. Type of training was offered in new manager training.



6. Topics participants indicated they needed additional help with.



7. Existence of a document detailing roles and responsibilities.



OSELP Itself: Reflections on Impact, Effectiveness and Potential

Authors: Lindsay Brown (SRNL), Donald Ferguson (NETL), David Micheletti (PPPL), Christopher Tassone (SLAC), Christina Wildfire (NETL)

Throughout the National Laboratory complex there are a variety of leadership development programs, some of which are developed exclusively for a particular laboratory or organization while others may be available to multiple labs. The Oppenheimer Science and Energy Leadership Program (OSELP) is differentiated by the fact that it comprises a cohort from all 17 national labs, representing a diverse range of roles, and is focused on experiential learning through site visits hosted by each of the participating labs. The unique nature of this program was brought up over the course of the year during discussions held at site visits, with mentors, and with alumni. The focus of this Think Piece is to reflect on OSELP to identify components of this program which have been most impactful to both this current cohort, as well as alumni of the program.

The Department of Energy's 17 National Laboratories make up a complex ecosystem focused on science and technology that is unlike any other organization. The 16 Government-Owned, Contractor-Operated and one Government-Owned, Government-Operated laboratories are overseen by various DOE Offices for the purpose of fulfilling the DOE mission:

As shown in Figure 1 below, some of the laboratories focus on a single DOE program while others serve multiple programs over an extremely diverse range of topics from fundamental science on the building blocks of the universe, health, energy and the environment, and national security. Each of the laboratories function independent of the others in a unique fashion of "coopetition," or cooperative-competition, in which they are at times competing for the same pools of funding and other times collaborating to meet mission objectives.

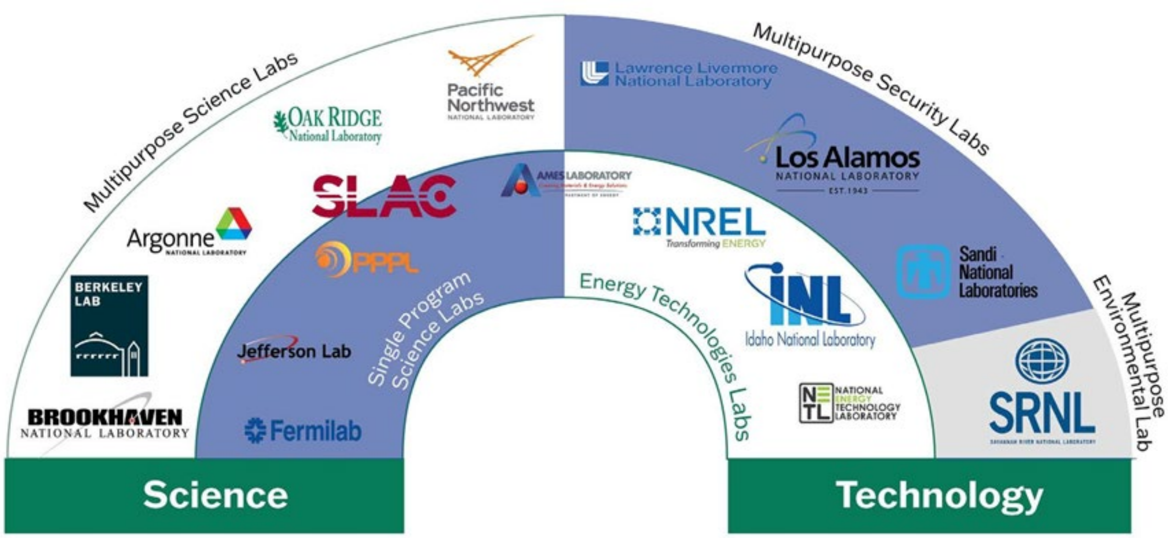


Figure 1: DOE National Laboratory Arch categorizing the lab focus as single or multipurpose and those that are science, technology, security, or cleanup focused.

Each laboratory is unique in its capabilities, but all maintain world-class research facilities and an extremely skilled technical staff. The laboratories are neither academia nor industry but have various aspects of both with some laboratories supporting programs outside of the DOE mission (industrial customers, various local, state and federal agencies, and even foreign governments). Overall, this creates a very challenging environment for new staff, and in particular new lab leadership at all levels, to navigate.

To be an effective leader in the National Laboratory system, one must have some understanding of how the National Labs function as a system. The pressing mission challenges for which the labs were founded to address requires leaders which possess an enormous breadth of understanding. In comparison to leadership development programs such as Building Executive Leaders for Tomorrow (BELT), Laboratory Operations Supervisor Academy (LOSA), Laboratory Operations Leadership Academy (LOLA), and the Strategic Laboratory Leadership Program (SLLP), OSELP offers participants a unique view of DOE's National Laboratory complex primarily through site visits. These multi-day site visits enable participants to engage in discussions with senior leaders, tour lab capabilities, and explore our shared history. Discussion topics span macro to micro enabling participants to gain understanding of topics ranging from strategic decisions, human capital, infrastructure, operations, science and technology, national security, leadership, and career pathways.

To help facilitate reflection on OSELP a mixed-method survey was developed and provided to the current cohort, as well as the Oppenheimer Leadership Network (OLN). The objective of the survey was to understand outcomes from participation, identifying impactful components of the program, and identify opportunities for further benefit to hosting institutions. The full survey can be found in appendix A. Survey respondents spanned all National Labs, every cohort that has been through the program, a range of tenure within the lab system, and participation in other leadership development programs.

Career outcomes for OSELP alumni are generally positive, with 50% of respondents indicating that their position has changed during or after the program, and 25% of respondents characterizing these as promotions and the remainder as lateral movement. In addition to changes in professional status 63% of respondents indicated that their level of responsibility had increased since they began the program. These professional outcomes are not particularly surprising given the cohorts are selected at least in part for leadership competency, and this is further evidenced by the fact that over 77% of those surveyed had participated in other leadership development programs such as those mentioned above.

In order to understand what components of the program were differentiating, participants were asked to provide open responses describing what makes OSELP different from other leadership programs. Those responses were categorized into the following themes:

- **Direct Exposure to Labs and Leaders**: Participants valued the hands-on, in-person visits to various labs and interactions with senior leadership, which offered a unique, inside look at the operations and challenges specific to each lab.
- **Focus on the National Lab Ecosystem**: Unlike general leadership programs, OSELP provides a deep dive into the structure, culture, and mission of the entire DOE lab complex, which is not available in other programs.
- **Extended Engagement**: The year-long duration of OSELP allowed participants to build deeper relationships with cohort members and provided ample time to absorb and reflect on complex information.
- **Network and Relationship Building**: The program fosters strong, trust-based relationships among cohort members, creating a unique network across the national lab system that can be leveraged professionally.
- **Strategic and Systemic Perspective**: OSELP focuses on understanding and managing the DOE complex as a whole rather than individual leadership skills. This approach encourages participants to think about large-scale, systemic issues and solutions.
- **Candid Conversations**: Participants appreciated the open, honest discussions with lab leadership, where real challenges and operational nuances were openly discussed, providing insights that aren't typically addressed in other programs.
- **Understanding Unique Lab Cultures**: Exposure to the diverse cultures and operational styles across different labs helped participants gain a holistic understanding of the DOE system, enhancing their ability to lead within it.
- **Opportunity to Apply Leadership in Context**: Rather than just teaching leadership theory, OSELP allows participants to experience and observe leadership in authentic, operational science and technology environments, which many found more impactful than traditional classroom learning.

These themes collectively highlight that OSELP is less about individual leadership development and more about fostering a deep, system-wide understanding of the DOE labs, which participants found to be invaluable and distinct from other leadership programs. In addition to the open responses a set of Likert style questions ranking the impact of different program components were asked. The results are shown in Figure 2, and largely mirror the themes which arose from the open responses.

These responses indicate that exceptional value is extracted both from candid conversations with senior lab leadership, and the resulting discussions which enable the cohort to digest and internalize the lessons learned during site visits. Ultimately these conversations drive the development of strong bonds between cohort members, and result in a resilient professional network. Over 90% of respondents indicate that they were able to use the network and knowledge gained through OSELP to positively impact their home institution.

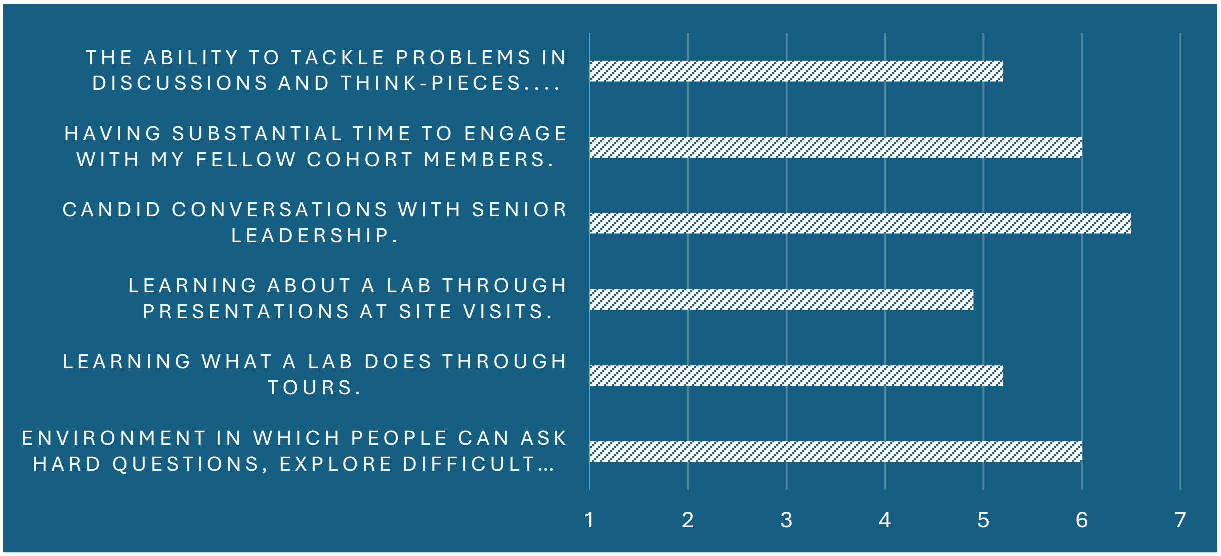


Figure 2. Averaged ranking of components of the OSELP program to the program's overall quality and effectiveness. In this scale, 1 is the least important and 7 is the most important.

The program outcomes which enabled participants to impact their home institution were varied and are shown in Figure 3. Interestingly, the professional network which was developed was not ranked as having the largest contribution for a participant's ability to impact their home institution, was the third ranked element behind insight into how the labs operate, and how DOE works. This indicates that the program was effective at demystifying the interaction between the labs and the department of energy and provides emerging leaders with approaches and tools which makes them more effective in their current role, as well as curating skills which will serve them as they progress professionally and have more interfaces back to DOE.

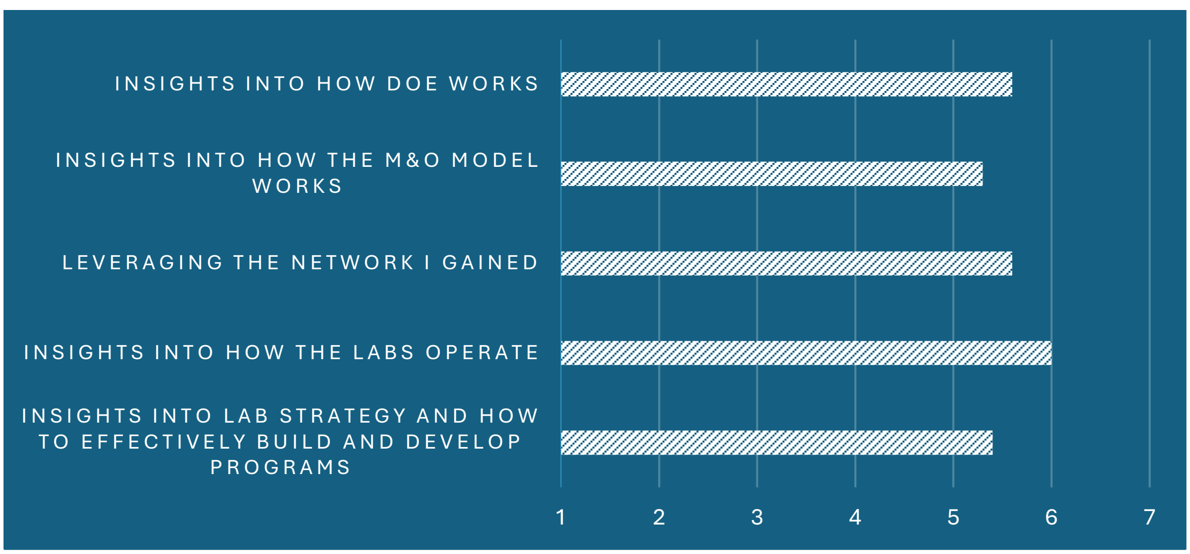


Figure 3. Averaged ranking of how the above components contributed to respondent's ability to positively impact their home institution from 1 (low) to 7 (high).

The survey inquired about a specific revision to the program to require fellows to explicitly have some obligation to give back to their home institutions after the program through mentorship of new fellows, presentations, or seminar series. Nearly 70% responded positively that this would be beneficial to the fellows themselves. This desire to translate their learning more broadly throughout their institutions represents an under leveraged resource among the alumni network to scale the learning that is achieved through the OSELP program. We propose three scenarios which are designed to both benefit the fellows and create a more tangible explicit benefit to their home institutions.

Scenario A – Utilize local alumni to develop and host an internal program which brings together a group from early-mid career level from a diverse set of job roles. This program could be tailored to the specific needs of the lab but should focus on direct exposure to mid-senior lab leadership, experiential learning through candid conversations, extended engagement, understanding lab culture, and the opportunity to apply leadership in context. Such a program would aim to achieve a subset of outcomes which are achieved in OSELP, but which could be executed at a single laboratory. The focus on early-mid career level, from a diverse set of job roles would potentially fill a gap in the development of emerging leaders, while also developing their network internally at their home institution increasing their effectiveness in their current roles as well as informing their understanding of career pathways.

Scenario B – Formalize a requirement for seminar style presentations for OSELP participants throughout the course, or at the conclusion, of the program. This approach creates an explicit expectation for fellows to transfer learning from across the lab system back to their home institutions. The target of the seminar series could vary depending on the fellow, and needs of the laboratory, but could for example focus on communicating best practices, shared challenges, demystifying DOE-Lab-Contractor relationships, or shared history. This expectation could also potentially benefit fellows by providing a focus for their learning throughout site visits on topics which they can translate back to their home institution.

Scenario C – Leveraging local OLN chapter to mentor current fellows. The experiential nature of the OSELP program is nearly universally viewed positively by alumni. However, the lack of explicit structure to the program does present some challenges to participants particularly in the early stages of the program. Alumni mentorship of current fellows could enable them to better prepare for site visits, provide coaching for digesting learning from site visits, and ultimately enable them to extract even more from the program. This approach would also have the added benefit of strengthening the local network of trained mentors to enable career development more broadly at each lab.

OSELP stands out as a transformative initiative within the National Laboratory system, offering participants a unique and comprehensive perspective on leadership through experiential learning. By fostering deep connections across the DOE complex, promoting candid discussions with senior leaders, and providing insights into the intricacies of the lab ecosystem, OSELP equips its fellows with the knowledge and networks needed to drive meaningful impact within their institutions. The proposed scenarios for enhancing alumni engagement and scaling the program's benefits underscore the untapped potential within the OSELP network to amplify its influence. Through mentorship, structured knowledge-sharing, and localized leadership programs, OSELP can further solidify its role as a cornerstone of leadership development in the National Laboratory community, ensuring lasting benefits for both participants and the broader DOE ecosystem.

Appendix A

Survey Sent to OSELP Cohort 7 and OLN

Survey Results Available Upon Request

OLN Survey on OSELP and Management Training

About You

Please provide your name.

At which National Lab were you employed when you began OSELP?

What was your role at the time you began your OSELP experience?

What National Lab do you currently work for?

What is your current job title?

Which OSELP cohort were you in?

In total cumulative years, please estimate the number of years you have worked in the National Lab system.

- ○ 0 - 5 years
- ○ 5 - 10 years
- ○ 10 - 15 years
- ○ 15 - 20 years
- ○ 20 years +
- ○ NA

If applicable, how many years have you worked at your current lab?

- ○ 0 - 5 years
- ○ 5 - 10 years
- ○ 10 - 15 years
- ○ 15 - 20 years
- ○ 20 years +
- ○ NA

OSELP Program Structure

How strongly do you agree or disagree with the following statement? **OSELP cohorts should consist of members with diverse backgrounds that span job roles—i.e., cohorts should include fellows that represent both mission support roles and technical staff.**

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? **As part of OSELP site visits, there is value to seeing a broad spectrum of labs–even those with the same sponsor–in order to provide a context for understanding differences, similarities, redundancies in mission, culture, and strategy.**

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? OSELP should be altered to include formal leadership training as part of its curricular focus. Here "formal" is broadly defined as a training element that is explicitly focused on developing individual leadership skills.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? **OSELP would be improved by only having fellows visit 4 – 6 Labs in a year in order to provide them with a flavor of the National Lab system.**

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? **Candid conversations with senior leadership on strategic and operational issues was an immensely important and impactful part of OSELP for me.**

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? **Developing relationships with the members of my cohort was a critically important and impactful part of my OSELP experience.**

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

How strongly do you agree or disagree with the following statement? **I believe I could have developed just as strong relationships with my cohort members if we had only visited 4 – 6 Labs throughout the year.**

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Please indicate your level of agreement with the above statement.	○	○	○	○	○

Please rank the following components of the OSELP program in order of importance to the program's overall quality and effectiveness. In this scale, 1 is the least important and 7 is the most important. Multiple items can have the same rating.

	1	2	3	4	5	6	7
The effectiveness of the OSELP Director and staff in creating an environment in which people can ask hard questions, explore difficult issues, and come together as a group that listens to each other.	○	○	○	○	○	○	○
Learning "what" a Lab does through tours.	○	○	○	○	○	○	○
Learning about a Lab through presentations at site visits.	○	○	○	○	○	○	○
Candid conversations with senior leadership.	○	○	○	○	○	○	○
Having substantial time to engage with my fellow cohort members.	○	○	○	○	○	○	○
The ability to tackle problems—in discussions and think-pieces—on issues of real importance to the future of the National Lab system.	○	○	○	○	○	○	○

As a potential revision to OSELP, do you think it would be beneficial for fellows to have some obligation to give back to their home institution after their yearlong fellowship—e.g., through mentorship of new fellows, giving presentations on what they learned, etc.

○ Yes

○ No
○ Unclear

Have you been a participant in any of the following leadership development programs? If so, please select all that apply.

☐ Strategic Laboratory Leadership Program (SLLP)
☐ Building Executive Leaders for Tomorrow (BELT)
☐ Project Leadership Institute (PLI)
☐ Laboratory Operations Leadership Academy (LOLA)
☐ Laboratory Operations Supervisor Academy (LOSA)

Other than the programs listed above, have you been a participant in other leadership development programs sponsored by or affiliated with a National Lab?

○ Yes
○ No

Briefly describe what makes OSELP different, if at all, than other leadership programs you've taken. Is this difference good or bad?

Career Impacts

Please indicate your level of agreement or disagreement with the following statement: **I was able to use the network and the knowledge I gained through OSELP to positively impact my home institution.**

	Strongly disagree	Somewhat disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Not applicable
Please indicate your level of agreement with the above statement.	○	○	○	○	○	○	○

Please rank how the following contributed to your ability to positively impact your home institution. In this scale, 1 is the least important and 7 is the most important. Multiple items can have the same rating.

	1	2	3	4	5	6	7
Insights into Lab strategy—how to effectively build and develop programs	○	○	○	○	○	○	○
Insights into how the Labs operate	○	○	○	○	○	○	○
Leveraging the network I gained	○	○	○	○	○	○	○
Insights into how the M&O model works	○	○	○	○	○	○	○

	1	2	3	4	5	6	7
Insights into how DOE works	○	○	○	○	○	○	○

If your position changed during or after OSELP, how soon did this change occur? We realize your position may have changed multiple times since completing OSELP. This question is about your first position change after the program.

- ○ Change occurred during OSELP
- ○ < 6 months after OSELP
- ○ 6 - 18 months after OSELP
- ○ 18 - 36 months after OSELP
- ○ > 36 months after OSELP
- ○ It did not change

If you indicated that your position changed in response to the prior question, please characterize the change using the following categories.

- ○ The change was a promotion.
- ○ The change was a lateral move.
- ○ It's complicated.

Since you began as an OSELP fellow, how has your level of responsibility changed in the Lab or other organization (or in a subsequent Lab, if you have moved)?

- Significantly increased
- Slightly increased
- No change
- Slightly decreased
- Significantly decreased

Understanding Management Support at the National Labs

Does your Lab offer new manager training?

- Yes
- No
- I don't know
- NA

If your Lab offers new manager training, which of the following topics does it cover?

- Understanding management styles
- Effective communication
- Conflict resolution
- Understanding the organization
- Strategic planning
- How to run and grow impactful programs
- Financial and budget managment
- Hiring, performance evaluations, and promotions

- ☐ DEIA training
- ☐ How to be an effective mentor
- ☐ Compliance with rules and policies
- ☐ Project management
- ☐ Change management

When you became a manager, which of the following did you find yourself needing help with?

- ☐ Understanding management styles
- ☐ Effective communication
- ☐ Conflict resolution
- ☐ Understanding the organization
- ☐ Strategic planning
- ☐ How to run and grow impactful programs
- ☐ Financial and budget managment
- ☐ Hiring, performance evaluations, and promotions
- ☐ DEIA training
- ☐ How to be an effective mentor
- ☐ Compliance with rules and policies
- ☐ Project management
- ☐ Change management

For new manager training within the National Labs, what additional topics do you think would be helpful?

For new managers at your Lab, how much coverage (funding to cover time) do they receive?

- 0%
- 1 - 5%
- 6 - 10%
- 11- 15%
- 16 - 20%
- 21 - 30%
- 31 - 40%
- 41 - 50%
- More than 50%
- NA or it's more complicated than this.

Do you think the percentage of coverage provided managers at your Lab for management duties is sufficient?

- Definitely not
- Probably not
- Might or might not
- Probably yes
- Definitely yes

At your Lab, for first-line supervisors, what percentage of their time is generally allocated toward people management? Note that this question is different from coverage, which relates to the amount of funding available. This question is about how much time—irrespective of funding—first-line supervisors have allocated to people management.

0 10 20 30 40 50 60 70 80 90 100

0%

Do you think the percentage of time allocated to first-line supervisors at your Lab for people management is sufficient?

- ○ Definitely not
- ○ Probably not
- ○ Might or might not
- ○ Probably yes
- ○ Definitely yes

Is the time allocated to first-line supervisors at your Lab for people management required, a best practice, or up to the individual to set?

- ○ Required allocation
- ○ Best practice / guidance
- ○ Entirely up to the individual's discretion
- ○ Other

At your Lab, is there a document detailing the roles and responsibilities of each position in the organizational chart?

- ○ Yes
- ○ No
- ○ I don't know

Does your Lab have a defined professional development strategy for employees?

- ○ Yes
- ○ No
- ○ I don't know

Did you have a mentor at the Lab prior to entering management?

- ○ Yes
- ○ No

Do you currently have a mentor through the Lab, either informally or formally?

- ○ Yes
- ○ No

Do you have a peer-to-peer network that you rely on for a support system in your role as a manager?

- ○ Yes
- ○ No

Did you feel prepared for your first year as a manager?

- ○ Yes
- ○ No

Thank you for taking this survey—we'd greatly appreciate it if you would finish! - Cohort 7.

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Members of Cohort 7 at Sandia National Laboratories, April 2024

Front row (left to right): Susan Winters, OSELP Deputy Director; Ning Kang, INL; Carol Meyers, LLNL; Pia Wilson, PPPL; Ami Dave, FNAL; Kaila Raby, SNL; Michael Spata, TJNAF. Second row (left to right): Teresa Daniels, BNL; Luisella Lari, BNL; Kirstin Alberi, NREL; Christina Wildfire, NETL; Ronald Boring, INL; Ikenna Nlebedim, Ames; Chris Tassone, SLAC. Third row (left to right): Roderick Jackson, NREL; Katy Christiansen, LBNL; Kane Fisher, LANL; Eileen Crowley, FNAL; Lindsay Brown, SRNL; Katrin Heitmann, ANL; Jolante Van Wijk, LANL. Fourth row (left to right): Kevin Doran, OSELP Director; Douglas Higinbotham, TJNAF; Yarom Polsky, ORNL; Marcey Hoover, OSELP Senior Advisor; Donald Ferguson, NETL; Joe Cruz, PNNL. Fifth row: (left to right): David Micheletti, PPPL; Matthew Myrick, LLNL; Michael Descour, SNL. Not shown: Arianna Gleason, SLAC; Amanda Schoch, PNNL; Jim Serafin, ORNL; John Stevens, ANL.