UNIVERSITY COLLABORATION AT SANDIA NATIONAL LABORATORIES: POLICY PROPOSAL FOR THE LABORATORY FELLOWS PROGRAM

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EXECUTIVE SUMMARY

Sandia National Laboratories is facing a new era of constrained funding for basic research projects. The national laboratories will need to carefully evaluate strategic priorities, as Congress has lowered the lab-directed research and development budget (LDRD) from eight to six percent for fiscal year 2014. As outlined in greater detail in the following paper, this Congressional action will impact the scope of Sandia's exploratory research.

Sandia has used its exploratory research capacity to bridge basic and applied research in promising scientific areas. Nanotechnology, a field that is young, interdisciplinary, and highly technical, is a prime example of an area that holds great promise but requires significant investment. Facilities like the Center for Integrated Nanotechnologies (CINT) can bring together basic and applied researchers from multiple fields to enhance understanding of nanotechnology while simultaneously advancing its practical applications. Continued basic research to advance understanding of how materials behave on a nano-scale is prerequisite to many practical applications of nanotechnology.

CINT is positioned to undertake a program that supports young professors while they contribute to its basic research efforts. These "Laboratory Fellows" would be paid summer salary in exchange for attending Sandia during the summer and contributing to the basic research underpinning nanotechnology throughout the year.

This program would have many potential benefits:

- Young professors can provide basic research support at a fraction of the cost of laboratory personnel;
- Basic research is intrinsic to the university environment, thus young professors are happy to undertake projects that would otherwise be difficult for lab personnel to justify;
- Sandia can develop relationships with professors whose interests apply to the Laboratories' research priorities; and,
- Sandia can improve its university presence through young professors, who may help the Laboratory to recruit promising young students.

Though the program would have many benefits, there are some potential challenges:

- Because the Fellows would only be in residence for three months, continuity of research is a concern;
- Due to the scale of basic research, researchers might not have publishable results after the duration of the fellowship; and,
- Some professors might not wish to spend summers in a different geographical location.

Despite these limitations, a Laboratory Fellows Program has great promise. It is poised to provide Sandia National Laboratories with low cost, mission critical support in a time when the Laboratories' work is falling under greater scrutiny.

BACKGROUND

Sandia National Laboratories is a national security laboratory that has been striving to expand its mission since the fall of the Soviet Union in 1992. The Laboratory was established on November 1, 1949, the earliest days of the Cold War, with a very clear mission – to engineer the non-nuclear components of the United States' nuclear weapons.[1] Since that time, the role of nuclear weapons has evolved significantly for the United States. Though Sandia's nuclear weapons mission still holds considerable priority at the lab today, the Laboratory can no longer rely on the sort of "no-questions-asked" funding stream for the development of nuclear weapons.

Since the end of the Cold War, Sandia's mission has evolved from a national defense to a national security mission. In addition to its nuclear weapons work, Sandia focuses on international and homeland security concerns, as well as energy and climate problems.[2] In practice, this concentration results in a broad array of projects at Sandia including computing science, high energy density physics, bioscience, and microelectronics, among others.[3] These non-nuclear programs comprise about 49 percent of Sandia's budget, which amounted to a total of $2.8 billion in fiscal year 2013.[4]

Sandia still completes substantial nuclear weapons work, amounting to approximately 51 percent of its budget or $1.44 billion dollars.[5] However, its nuclear mission has changed since the Cold War, when it consistently worked to design new nuclear weapons. Now, Sandia contributes to the stockpile stewardship and lifetime extension programs, maintaining the safety, security, and reliability of the U.S. nuclear weapons complex. While some portion of the Laboratories' nuclear work will continue as long as the U.S. has a nuclear weapons arsenal to maintain, the scope of the work is not indefinitely guaranteed.

Sandia's budget for nuclear weapons-related projects is now largely dependent on treaties that affect the size of the nuclear weapons stockpile. In the near term, Sandia's nuclear weapons projects are projected to increase based on treaties like New START, which requires the U.S. to dismantle some of its nuclear weapons and results in significant work for the nuclear weapons lab complex. Additionally, the United States' commitment to extending the nuclear weapons lifecycle will require Sandia National Laboratories' continuing expertise. However, for the United States, the role of nuclear weapons is

1 (Mora 1999)

2 (National Academy of Public Administration 2013)

3 (Rottler 2012)

4 (Nuclear Watch New Mexico 2013)

5 (Nuclear Watch New Mexico 2013)

decreasing. The last proposed new nuclear weapon was canceled in 1991.[6] Since that time, the U.S. has only decreased the size of its stockpile.

In order to position itself for the long-term, Sandia will need to continue to invest in non-nuclear aspects of its mission. Though the nuclear component of Sandia's work is projected to continue indefinitely, its relative importance to the Laboratories' mission will likely continue to diminish. The increasingly constrained funding environment and the resulting Congressional oversight means that Sandia must undertake research in a different method than it once did. Pressure is increasing on the national laboratories to develop technologies with direct commercial application and to spend less money in the process of making the discovery.

Nanotechnology at Sandia

Nanotechnology is a prime example of where Sandia National Laboratories' non-nuclear expertise can yield tremendous benefits for the nation. Through the Center for Integrated Nanotechnologies (CINT), Sandia and its partner, Los Alamos National Laboratory, offer a facility too expensive to be constructed outside of a national laboratory. This facility, which is far larger and more advanced in both scale and scope than nanotechnology centers available at research universities, gives Sandia a unique ability to build and test new devices. The purpose of the facility is to integrate the basic research being done in nanotechnology into practical applications on a larger scale.

The field of nanotechnology encompasses all research on which material is studied or manipulated at one to 100 nanometers. Nanotechnology therefore has a great deal of applicability across fields of scientific research. The gains of the study of nanotechnology apply to the development of precise applications across a wide spectrum of disciplines, such as cancer treatment delivery vehicles, but also relate more broadly to understanding physical interactions of matter. As a result, fields interested in nanotechnology include surface science, organic chemistry, molecular biology, semiconductor physics, and others.[7] Due to this scope, nanotechnology applications are broad ranging. Practical applications range from advancing medical treatments to developing sensors for chemical and biological agents to changing the manufacturing process. The lab, which is interdisciplinary by nature, provides a unique environment to bring these often-segregated fields together to yield practical applications from nanotechnology.

However, while nanotechnology holds great promise for practical applications, it is also very young. The field of nanotechnology itself was only born in the 1980s, and much of the current work on nanotechnology did not begin until the mid-2000s.[8] Thus, much remains to be learned about nanotechnology, and many of these potential projects will require years of research before practical applications can be deployed. Therefore, basic research remains critical to yielding applied results from nanotechnology. The scale of

6 (Gibson 2006)

7 (Saini, Saini and Sharma 2010)

8 (Drexler, et al. 2007)

Sandia's facilities, combined with its interdisciplinary nature and the Laboratories' willingness to undertake basic as well as applied research projects makes it an ideal place to advance nanotechnology.

Development and Innovation at Sandia

Because nanotechnology is a relatively new field, much remains to be discovered about how materials behave on a nano-scale. Nanotechnology as a field still relies heavily on basic science and research in order to develop practical applications for the research. The role of CINT is to bring together basic science and other types of research to develop practical applications, but much of the work at CINT is in its infancy. By its very definition, CINT relies on basic science in order to move nanotechnology towards practical application.

Development of commercially applicable technology requires a great deal of research in multiple steps. Work on applied research requires an understanding of the fundamental science underpinning the project. Often, technology development reveals gaps in knowledge about the basic science. In a young field like nanotechnology where multiple disciplines are pursuing commercial applications, these discoveries are frequent.

Therefore basic research, traditionally defined as research undertaken for knowledge advancement rather than a particular purpose, plays a key role in technological development. Basic research presents a problem for industry because while it requires significant investment of time and resources, its immediate results do not yield profits. Furthermore, basic research projects can last for years or even decades and fail to answer the fundamental questions underpinning the research. As the national laboratory system is pushed towards applied research, justifying the important basic research work is becoming more difficult for it to pursue.

Universities – An Engine for Basic Research

Universities are the single largest contributor to basic research, accounting for as much as 60 percent of that work.[9] University professors have the protection of their institutions to continue to conduct basic research, and they also have access to graduate students to help with their research portfolio. Furthermore, publications advance university professors' promotion packages, and papers based on basic research findings are sought by academic journals. Universities can often undertake projects for less than they would cost to execute at the national labs because their institutional overhead is lower.

Universities have maintained their preeminence in basic research for a number of important reasons, including its fit with the nature of an institution of higher learning as well as universities' departmental structure. But more importantly, universities provide the most inexpensive home for conducting basic research.

9 (Arizona State University 2006)

However, universities face the challenge of maintaining the infrastructure necessary to support basic research work in multiple fields. Instrumentation and material for experiments can cost hundreds of thousands of dollars each year per faculty member on the project level, and the infrastructure to support basic research for a department might run into the millions. But the university system is not immune to the funding constraints facing the national labs – 57 percent of funding for basic research comes from government sources.[10] On an individual level, this funding provides a budget for experimental costs like materials and instruments, stipends for graduate students, and summer salary support for professors. It also gives government the opportunity to encourage competition among research universities, while the universities can maintain standing expertise in disciplines regardless of Congress' funding priorities.

Because universities house multiple departments, their researchers can form powerful teams to address interdisciplinary research problems in fields like nanotechnology. However, those same traditional departmental silos make building the infrastructure to support interdisciplinary programs challenging. As nanotechnology spans many disciplines, university researchers have traditionally relied on the labs' user facilities to carry out their experiments. This reliance has benefited both the university system and the national laboratories; government investment improves the university system, which in turn improves education of government personnel. However, this system has not always yielded the maximum benefit for the national laboratories.

Congress Threatens Basic Research Budget

Despite its importance, basic research can be the most difficult area to justify for a national laboratory because the outcomes can take time and are not necessarily directly applicable to a specific project or technology. Yet, the absence of basic research can greatly limit the ability of the labs to conduct work on nanotechnology. Because much remains poorly understood about nanotechnology, the field relies more heavily on basic research than on other areas of Sandia's work.

Historically, the national laboratories have pursued basic research using discretionary funding. From 2007 to 2013, the laboratories allocated up to 8 percent of their overall budgets for discretionary lab directed research and development (LDRD).[11] Congress designed the LDRD program to give the national laboratories the ability to conduct "highly innovative and exploratory research" at their discretion in addition to the projects explicitly defined in the laboratories' annual budgets.[12] LDRD projects are generally high-risk projects that have the potential to result in large advances for technology in many of Sandia's mission areas.[13] Through the LDRD program, Sandia can allocate money towards an appropriate balance of basic research, applied research, and

10 (Arizona State University 2006)

11 (Office of Science n.d.)

12 (Brookhaven National Laboratory, 2014)

13 (Laboratory Directed Research & Development 2014)

use-inspired research. The spirit of LDRD funding has led the laboratories to allocate these funds towards projects with less well-defined outcomes than other areas of their budgets.

However, budgetary battles in Congress over the past year have threatened the health of the LDRD program. In October 2013, the Energy and Water Development Subcommittee of the subcommittee of the House Appropriations Committee that determines laboratory budgets passed a bill that limited LDRD funding to 4.5 percent of laboratory budgets in FY14. The subcommittee's argument for the limitation was that by limiting the basic research portion of the budget, more money could be allocated towards laboratory programs. In the bill passed in January 2014, Congress reduced the maximum LDRD rate to 6 percent.[14]

Though Sandia prepared for the decrease in the budgetary allocation for LDRD budget, Sandia Vice President and Chief Technology Officer Julia Phillips indicated that Sandia would need to "monitor LDRD spending carefully to make sure it does not exceed the 6 percent limit."[15] As a result, the Laboratories' ability to invest in basic research and higher-risk technology projects is limited by this budget decision. In essence, Congress challenged the value of basic research at the labs.[16] Sandia is facing increased pressure to demonstrate the return on investment in its LDRD programs.[17]

Though the Center for Integrated Nanotechnologies does not rely exclusively on LDRD funding, a significant portion of the projects that occur at the facility are LDRD projects. If LDRD budgets are increasingly threatened in budget cycles, lack of funding may result in underutilization of national laboratories' investment in research facilities, as well as the basic research, that underpins technological advancement. Furthermore, because the size of the LDRD budget is tied to the lab's overall budget, an overall budget decrease at the lab will also impact Sandia's ability to allocate funds to LDRD projects. In order to find a sustainable solution to funding issues, laboratories will need to increasingly look towards partnership opportunities. To support basic research needs at the laboratories, the U.S. university system is a natural partner based on its existing commitment to basic research.

A Fruitful History to Laboratory-University Collaboration

Sandia has a fruitful history of collaborating with universities and relies on these collaborations to recruit its next generation of laboratory professionals and to produce joint research and development products. Sandia's deepest collaboration occurs through the Campus Executive program. For this program, Sandia partners with approximately 20 schools, chosen based on careful alignment with Sandia's interests and strategic needs.[18]

14 (Miller 2014)

15 (Miller 2014)

16 (Gronlund 2013)

17 (Miller 2014)

18 (University Partnerships 2014)

Sandia also partners with universities on a program-by-program basis. In the 2013 fiscal year, Sandia awarded 499 contracts to 97 different universities. The scope of this program demonstrates Sandia's success in partnering with universities. The Laboratories recognize the benefits offered by universities to its research and the value of exposing students and researchers to the type of work done at the lab.

However, Sandia does not fully leverage its relationships with universities in a strategic way to advance its work in basic research. While it collaborates with universities on many levels, it does not currently leverage them as a resource to fulfill basic research requirements of its projects. As Congress continues to threaten the size and scope of the labs' discretionary research budgets, Sandia has an opportunity to expand its work with universities to fulfill the requirements of its mission.

Improved university collaboration is a particularly elegant solution for the funding challenges facing Sandia and, by extension, its nanotechnology program. Existing university strength in basic research, combined with its mission orientation towards basic research, makes it a natural resource for Sandia. Furthermore, universities will continue to require access to national laboratory facilities, as building the infrastructure for interdisciplinary fields like nanotechnology is too costly on an institutional level.

The Center for Integrated Nanotechnologies' vision "to become a world leader in nanoscale science by developing the scientific principles that govern the design, performance, and integration of nanoscale materials"[19] is an example of a quickly evolving area of research that can benefit from such basic research support. In fact, CINT declares that "[i]ntegration itself is key to the exploitation of nanomaterials, and the scientific challenges that it poses are at the heart of CINT's mission"[20] and advertises one of Sandia's goals as the forming of strategic partnerships through outreach activities to university faculty.[21] The current CINT research environment fosters innovation and research integration, which is a favorable research community to enact a new laboratory-university collaboration policy.

The following section outlines a program for university collaboration in nanotechnology that will help Sandia to achieve its mission despite current and possible future budget constraints. If this proposed laboratory-university collaboration policy is proven successful at CINT, then Sandia should implement this collaboration effort across all research focus areas at the National Laboratories.

19 (Center for Integrated Nanotechnologies 2009)

20 (Center for Integrated Nanotechnologies 2009)

21 (Center for Integrated Nanotechnologies 2009)

PROPOSAL: CINT LABORATORY FELLOWS

Overview of CINT Laboratory Fellows

The proposed laboratory-university collaboration program is named "CINT Laboratory Fellows". The Laboratory Fellows program encompasses input gathered from Sandia managers and scientists, as well as university professors. This program supports and aligns with Sandia National Laboratories' research collaboration goal to foster incentivized, committed, and cost efficient basic research expertise. The CINT Laboratory Fellows program meets Sandia's objective to form strategic partnerships with the National Laboratories' research staff and university faculty. This program supplements Sandia's current knowledge base and advances the Laboratories' research initiatives by employing collaborative efforts that leverage vast quantities and qualities of information.

CINT Laboratory Fellows fosters long-term research collaboration between inspired Sandia researchers and university professors. This program provides extensive research collaboration opportunities but does not require the Laboratory Fellow to be physically present at Sandia National Laboratories over the entire extent of the collaboration time period. The Laboratory Fellows program is modeled after a collaboration program administered by Argonne National Laboratory where full-time college or university faculty members collaborate with a staff scientist for a maximum of six months and are provided a stipend based on their yearly academic salary.[22] In comparison to Argonne's "Short-Term Appointments for Research" program, Sandia's Laboratory Fellows program does not restrict participants to full-time university staff and provides Laboratory Fellows with more extensive research collaboration opportunities.

Sandia's target market for the CINT Laboratory Fellows program is the young, untenured university professor who desires to further his academic career through work on technologically advanced and "cutting-edge" Sandia projects at user facilities. The professor's passion towards the invention of new technologies will drive a successful collaboration with a team of Sandia research staff.

To further collaboration efforts, Laboratory Fellows will be listed on a webpage.[23] In addition to identifying the Sandia research projects each Fellow has participated or is currently participating in, the listing will also include a brief description of the professors' research background and interests. Sandia staff can leverage this Laboratory Fellows Page as a networking tool. Researchers are able reach out to Fellows with specialized interests specific to Sandia staffs' projects.

Responsibilities and Opportunities for Fellows

An ideal, more enduring laboratory-university collaboration effort with Sandia National Laboratories should include numerous research and professorial staffs and span

22 (Faculty Research Participation - Short-Term Appointments 2014)

23 (Current Postdoctoral Researchers 2014)

across a minimum time period of ten years. A large number and variety of research and professional staff participation in the CINT Laboratory Fellows program will encourage cross-discipline collaboration efforts and create the potential to advance technology development. A long-term collaboration relationship is in the interests of both research scientists and university professors. All participants will have an ample amount of time to become familiar with laboratory and university research, environments, and collaborations expectations and flourish in the CINT Laboratory Fellows program.

The CINT Laboratory Fellows collaboration agreement will last the length of the contracted project in order for strategic and prosperous partnerships to form between the National Laboratories' research staff and university faculty. The length of CINT projects varies, but it should average between three and five years. To ensure efficient collaboration, professors will be actively engaged with Sandia research scientists throughout the project. Both the projects' scientists and professors are responsible for maintaining regular communication. This communication will focus individual and team research efforts to ultimately achieve the project goal. However, discussion should not be restricted to scientists and fellows on the same project. Cross-project communication will provide stakeholders with opportunities to leverage successes and difficulties in each others' research efforts.

Sandia will provide the CINT Laboratory Fellow's a summer salary during the time that the Fellow is conducting on-site research at Sandia National Laboratories. Although Laboratory Fellows will be in regular contact with their projects' research scientists at Sandia, the Fellows will visit the laboratory and perform a majority of their research during the summer months (mid-May through mid-August). Recognizing that a three-month visit to Sandia National Laboratories can be both a financial and lifestyle hardship, this stipend is an important aspect of the Laboratory Fellows program. Sandia should also consider compensating the professor for travel expenses, collaboration, and research efforts that span the length of the CINT project.

Administering the CINT Laboratory Fellows Program

CINT Laboratory Fellows' program funding sources are dependent on the specifics of each project. Request for Proposals in support of Laboratory Fellows projects are drafted and submitted by Sandia research scientists already assigned to the CINT project. This CINT project is either funded with LDRD funds as a Laboratory priority, or has been awarded via a Government or Corporate contract with Sandia. In either case, LDRD funds can be allocated to support CINT Laboratory Fellows. In the case of a contracted project, the possibility exists that the supporting Laboratory Fellows could receive funding through a sub-contract.

Sandia National Laboratories should develop an internal process that allocates an annual LDRD budget towards the Laboratory Fellows program. In conjunction, Sandia can require that the Laboratories' LDRD projects use a portion of its funding allocation towards Laboratory Fellow collaboration. CINT should also establish research goals that incorporate the funding of Laboratory Fellows into applicable government and corporate

contracts. The CINT Laboratory Fellows program and its associated funding are distinct and separate from Sandia's Campus Executive Program large university partnerships.[24]

Sandia National Laboratories will compensate CINT Laboratory Fellows' research through a direct contract between Sandia and the individual CINT Laboratory Fellow. This direct contract serves two main purposes. First, the Laboratory Fellow contract will specify project goals, timelines, and required deliverables. A solid basis for collaboration, the document will clarify project expectations from the view of both the Sandia research scientists and CINT Laboratory Fellows. Second, the contract will serve as an agreement between Sandia and the Laboratory Fellow himself. The contract alleviates the university "middle-man", which in turn allows direct funding transmission from the Laboratory to the professor.[25]

Sandia will request, accept, and select user proposals for CINT. The CINT Laboratory Fellows program is unique because user proposals will be specific to the laboratories' current and planned research projects. This process generates research efforts that are of high value to CINT research staff and supplement traditional CINT projects.

CINT Laboratory Fellows Request for Proposals will be released in alignment with Sandia's government, corporate, and Lab Directed Research Development (LDRD) projects. Similar to Sandia's current Call for User Proposals process, submissions are required to address the following elements:[26]

- Brief description of the state of research in this area and how the applicant's work is advancing the field.
- What is(are) the expected impact(s) of this project?
- What specific work will be performed at the Laboratory Fellow's institution in preparation for, or in support of, the proposed CINT work?
- What specific tasks will be performed by the Laboratory Fellow in conjunction with CINT? For each task, include task duration, expected task outcome, requested instrument(s) and CINT staff engagement.

Two differentiating factors exist between Sandia's current call for user proposals and the Laboratory Fellows Request for Proposals. The primary distinction is that CINT research scientists identify the main scientific question(s) being addressed in the Fellow's project. An additional distinction is that Laboratory Fellows Request for Proposals are communicated directly from a CINT research scientist to university professors via the CINT Laboratory Fellows webpage. Interested applicants can frequently visit the Laboratory Fellows site to reference the Research Compilation listing of all advertised Request for

24 (Moreno 2014)

25 Similar to this program: http://www.dep.anl.gov/p_faculty/frp.htm

26 (Center for Integrated Nanotechnologies 2014)

Proposals.[27] In alleviation of a middleman, submissions do not need to be sent through university administration.

For example, Sandia National Laboratories is either awarded a Department of Energy (DoE) contract or LDRD funding for a semi-conductor materials project. Sandia research scientists assigned to this contract identify basic research efforts associated with and required for fulfillment of the semi-conductor materials project that can be performed by university professors. These research scientists disseminate a Laboratory Fellows Request for Proposal that outlines the necessary research effort. Professors then apply for this Request for Proposal by addressing the published requirements and providing a summary of their proposed research.

SANDIA NATIONAL LABORATORIES' POLICY BENEFITS

Expanded Knowledge Base

The CINT Laboratory Fellows program utilizes the fellow's university background in basic research to further applied research.[28] Currently, there are research areas in which Sandia needs more expertise.[29] Fellows fill gaps in knowledge and empower CINT to be successful in their current business. Further, this larger knowledgebase allows CINT to pursue projects in increasing numbers and varieties. This Fellowship allows for new ideas to come from new professors and gives incentives to these professors to encourage them to pursue these ideas.

The CINT Laboratory Fellows Program will maintain continuous access to individual Fellows. During the contract period, Sandia staff will be able to access Fellows. This encourages Sandia staff to reach out to the Fellow and leverage their knowledge.

Relationship Building

The CINT Laboratory Fellows program will build relationships with individual professors instead of with a university as a whole. This gives Sandia National Laboratories an opportunity to foster a relationship that will last throughout the young professor's scientific career. During this time, young professors will contemplate their career path. Experiences at CINT will allow the fellows to experience the national laboratory way of operating, such as working on a deadline and deliverable requirements. Fellows can make career decisions with more complete information and may allow Sandia to convince the professor to stay on as a staff scientist.

Professors remaining in academia will leave with greater sensitivity to Sandia's mission than had they simply been users of the CINT facility. Even if they do not continue to

27 (Catalog for Student Research Participation 2014)

28 (National Research Council 2005)

29 (Moreno 2014)

work with the Laboratories, professorial experience will pay dividends to their students who may be interested in pursuing a career with the national laboratories. This fellowship will expand Sandia's access to future students, furthering Sandia's recruiting possibilities. Overall, this policy will increase Sandia's access to talented scientists and consequently, their knowledge.

Inexpensive

It is getting harder for Sandia to justify large expenses for basic research. Stronger demand is being placed upon applied research that can be marketed. By bringing in a university professor, CINT is able to access this knowledge at a subsidized rate.[30] The CINT Laboratory Fellows Program is relatively inexpensive by working directly with the professor. The money would only be for their summer salary; this salary would not have to flow through the university and thus, not be subject to the overhead of the university.

The omission of university administration not only simplifies and expedites the CINT Laboratory Fellow's funding process but also enables the conduction of more research. Under traditional fellowship programs, universities generally charge an administrative fee or overhead cost that is generally 50 to 60 percent of the contracted amount.[31] CINT Laboratory Fellows will leverage this university overhead "savings" to perform twice the amount of research that can typically be accomplished under a laboratory-university contract of similar value. By directly targeting the professors, the funding can be stretched further. The cost of this program would be directly related to the number of fellowships created.

Expanded Funding Opportunities

The CINT Laboratory Fellow Program will expand funding opportunities for Sandia. Collaboration partners the Laboratory Fellows with the National Laboratories. Sandia is constantly competing for federal funding outside of the normal budgeting cycle. This federal funding could be provided to any of the national laboratories.

It is common to analyze the merit of a contract based upon individuals listed on the proposal. The National Science Foundation specifically looks at the qualifications of the individual, team, or institution that will conduct the proposed activities.[32] CINT is more attractive by having certain key researchers on contract.[33]

30 (Phillips 2014)

31 (Moreno 2014)

32 (National Science Foundation 2014)

33 (Shinn 2014)

UNIVERSITY AND PROFESSOR POLICY BENEFITS

Equipment Access

The primary benefit for professors to participate in the fellowship is to have complete access to CINT's laboratory facilities. During the summer session, Fellows will be able to use the much-needed lab infrastructure to do their own research projects.

Alternate Environment

The CINT Laboratory Fellow Program will give professors an opportunity to experience research outside the academic environment. Nanotechnology at CINT is differentiated by the work being inspired by the application instead of academic style research.[34] Fellows will experience application and objective focused research. Fellows are able to hone their research skills outside of academia. Even when projects are not a major success, the experience can still be positive in a way that influences the professors' research. CINT would offer these professors the opportunity to research topics that they are interested in, allowing them to do cutting edge research. Collaboration of this type offers the direct benefit of research experience.[35] This experience allows the Fellows context for their career trajectory.

This Fellowship would also mitigate the frustration of miscommunication between the professors and Sandia National Laboratories.[36] Even with all of the communication methods of today, Fellows benefit from being onsite. Fellows will be included in scheduling conversations. This way the Fellows are completely aware of all deadlines and time constraints placed on Sandia National Laboratories.

Faculty Enrichment

Universities will also benefit from this fellowship program by getting more experienced and disciplined faculty. Professors have experiences that they could not have elsewhere. Laboratories offer an environment for continued training and education.[37] Fellows will have first hand experience with cutting edge research. This knowledge will flow into the classes that they teach and further their publications. In essence, the Program enriches the faculty while universities retain them as staff. Laboratory Fellows create a more prestigious faculty, which benefits the university by attracting high-level students and funding opportunities.[38]

This fellowship program would also enhance the professors' knowledge of how laboratories are setup and run. Fellows will gain experience in national laboratories' best

34 (Shinn 2014)

35 (Ham & Mowery, 1998)

36 (Stoll 2014)

37 (National Research Council 2005)

38 (Phillips 2014)

practices. This knowledge is very important to universities that do not have the insight to setup their own laboratories.

Summer Salary

It is common for a professor to be on a nine-month contract.[39] This contract type, an additional burden on the young professor working towards tenure, only pays professors for nine months out of a year. To achieve tenure, professors are usually expected to research and publish over the summer months on their own time. The CINT Fellowship program would award Fellows with a stipend based upon their academic salary, which allows professors to continue their research and receive a summer stipend.[40]

Network Enhancement

The value of a strong network cannot be over estimated.[41] Fundamentally, social networks are created when one person introduces two acquaintances to each other.[42] This is an old and very reliable way of building networks. Primarily, universities rely on this method. Senior faculty members frequently introduce junior faculty members to their contacts.[43] This network establishes the connection, but does not lead to immediate collaboration.

The CINT Fellowship Program will quickly expand connections. Fellows will be put into research teams in the laboratories during the summer, where they will interact with peers with similar research focuses. Collaboration teams will form that might not have been introduced otherwise. Further, these relationships will be developed over 3-5 years. Connections will strengthen over the course of the fellowship. Fellows will leave with strong networks and benefit from them throughout their careers.

In the sciences, strong networks offer two main benefits: expanded collaborations and increased co-authorship. First, the probability of two scientists' collaborating increases with the number of collaborations the two scientists have in common.[44] The collaboration that the Laboratory Fellow undertakes increases the probability of later collaborations with scientists connected to CINT. Second, two individuals have an increased probability of future co-authorships when the number of common co-authors increases.[45] CINT increases the connections of its Fellows, thus increasing the probability of co-authorship. These benefits expand the Fellows' research and career opportunities.

39 (Kreuter 2012)

40 (Knispel 2012)

41 (Kenny 2014)

42 (Davidsen, Ebel and Bornholdt 2002)

43 (Korman 2014)

44 (Newman 2001)

45 (Martin, et al. 2013)

POTENTIAL POLICY CONCERNS

Stakeholder interests were recognized in the drafting of the CINT Laboratory Fellows Program policy. As is the case with the introduction of all policies, there are potential concerns that must be recognized and, if possible, eliminated. Although one may consider a few of the policy concerns as substantial, an argument can be made that the overall research benefits provided by the Laboratory Fellows Program significantly outweigh its potential stakeholder concerns.

Sandia National Laboratories' Policy Concerns

CINT personnel may resist the Laboratory Fellows policy using the claim that Fellows can neither contribute an adequate quantity of research nor deliver quality research under the strict time constraints of CINT projects. CINT Laboratory Fellows collaborations are specific projects contracted to Sandia National Laboratories, which is responsible for providing specific contract deliverables and adhering to strict contract deadlines. Entrusting a stipend-associate with research efforts necessary to fulfill the requirements of contracted deliverables is often a controversial topic to Laboratory research scientists. This subject can be especially controversial when the majority of a Fellow's research must be completed during his annual three month Laboratory visitation period. Furthermore, Laboratory scientists typically work at a faster pace in comparison to university researchers. That being said, one can understand why Sandia's research scientists may be hesitant to anticipate and have confidence in complete and expeditious university research efforts.

The Laboratory Fellows Program addresses the potential concern of research timeliness with the laboratory-university researcher collaboration commitment that spans the length of Sandia's contracted project. This project-long commitment better vests professors and their research efforts into the project completion because the Fellows will be involved in the entire project instead of just for a project increment. For example, if the project length is three years, the Laboratory Fellow will have the opportunity to visit Sandia National Laboratories and perform nine months of in-residence laboratory research over the course of three summers. Inbetween visits to Sandia, Laboratory Fellows will stay in contact with project research scientists, a practice which will focus and progress stakeholder research efforts. It is important to note that all project researchers need to be cognizant and responsive to both professorial and scientific researcher circumstances, capabilities, and expectations.

Sandia National Laboratories may be hesitant to implement the CINT Laboratory Fellows Program because the program may interfere with Sandia's existing relationships with university laboratories and professors. Sandia recognizes that universities are "pipelines of talent" that need to be tapped.[46] In fact, Sandia does currently maintain university partnerships and, not counting networked researcher-professor collaborations,

46 (Shinn 2014)

collaborates with over 31 colleges and universities.[47] Some stakeholders may question whether the Laboratory Fellows Program will affect aspects of standing university partnerships. The expectations of the university staff accepted into the program may also be a concern to Sandia National Laboratories stakeholders. Understandably, Sandia does not want Laboratory Fellows to assume or rely on Sandia for a future full-time position.

Stakeholders should not be concerned with negative influences of university-laboratory partnerships associated with this policy. The nature of CINT Laboratory Fellows Program will strengthen current laboratory-university ties. The Program's unique and extensive collaboration projects will further foster university interest in Sandia projects, prolong collaboration timelines, and display Sandia's vestment in university collaboration efforts.

Sandia National Laboratories does often hire laboratory researchers involved with laboratory-university collaboration efforts. Consequently, the Laboratory Fellows program will not portray that Sandia *will* hire *all* Laboratory Fellows. The CINT Laboratory Fellows Program directly compensates the Fellows for their time spent on Sandia's research efforts; therefore, a follow-on hiring gesture is not expected. Rather than in pursuit of a position at Sandia, young professors, the CINT Laboratory Fellows target market, are likely to participate in the Laboratory Fellows program to supplement their university salary, research, and publication efforts.

University and Professor Policy Concerns

The CINT Laboratory Fellows Program is a policy that may cause university administrative concerns and may not appear attractive to university professors. The potential minimal administrative university inconveniences provide an overwhelming benefit to university professors.

Under Sandia National Laboratories' current university collaboration efforts, Sandia makes payment directly to the universities for professor and student research. Universities keep a portion of this payment for its overhead structure costs. Since the CINT Laboratory Fellows Program will be paying the professor directly, the university will not be administratively involved. Consequently, universities will not collect overhead funding from Laboratory Fellows projects.

The elimination of paying overhead costs is of great benefit to the CINT Laboratory Fellows program's overarching collaboration effort. The funding allocated to a Laboratory Fellows project will be contributed, in its entirety, towards research efforts. This funding circumstance will facilitate the completion of a greater amount of research for the same amount of Sandia funding contributions. In addition, the Laboratory Fellows will be receiving a higher stipend. Higher financial compensation will make the CINT Laboratory Fellows Program a more attractive supplemental income option to professors in comparison to other potential summer research or income opportunities. The extension

47 (Moreno 2014)

and promotion of Laboratory Fellows research efforts ultimately create an environment that fosters efficient research practices, as research conducted at universities is generally less expensive than identical research conducted at other laboratories.

The CINT Laboratory Fellows Program may not be attractive to the program's target market professors because these professors are usually seeking research and activities that develop a tenure package. Sandia National Laboratories' renowned background in national security and energy research will definitely attract professors looking to participate in "cutting edge" research. However, every professor constantly strives to further his tenure package with publications. The CINT Laboratory Fellows Program cannot guarantee a professor publishable research results, but the program's application process allows professors to hand-pick projects for which they wish to apply. A professor can manage his Laboratory Fellow applications to include only projects that he perceives to involve research efforts that will benefit his future career goals.

CONCLUSION

Sandia National Laboratories' evolving research initiatives requires collaborative efforts to leverage a great quantity and quality of information applicable to the Laboratories' projects. As the current fiscal environment continues to place constraints on Sandia's research efforts, especially with respect to the Laboratories' six percent LDRD funding appropriation maximum, efficient research management becomes of greater importance. The Laboratory Fellows Program is an excellent example of a policy that will employ professorial strengths in basic research to excel Sandia's applied research efforts.

The CINT division of Sandia is the ideal laboratory sector in which to first employ the Laboratory Fellows Program. In its infancy, CINT relies on basic research efforts to advance the development of applied research nanotechnology applications. Benefitting all stakeholders, university-laboratory collaboration in the Laboratory Fellows Program:

- Allows Sandia to focus its research efforts and associated funding on applied research, its field of expertise;
- Provides skilled, young professors with a summer salary stipend and the opportunity to participate in research efforts that support a larger, "cutting-edge" government or corporate project; and,
- Creates and fosters long-term collaboration efforts between laboratory and university research scientists that will promote research effectiveness for the future.

In summary, the CINT Laboratory Fellows Program provides Sandia National Laboratories with incentivized, committed, and cost efficient basic research expertise. Laboratory Fellows' expertise supplements Sandia's current knowledge base and advances the Laboratories' research initiatives, a system which enables Sandia National Laboratories to innovate and discover new technologies that strengthen the United States' technological superiority.[48]

48 (Mission 2014)

WORKS CITED

Argonne National Laboratory. *Catalog for Student Research Participation.* 2014. https://webapps.anl.gov/register/catalog/3.

—. *Current Postdoctoral Researchers.* 2014. http://www.anl.gov/science/postdocs.

—. *Faculty Research Participation - Short-Term Appointments.* 2014. http://www.dep.anl.gov/p_faculty/frp.htm.

Arizona State University. *Basic Research by Universities Is Critical to U.S. Innovation.* March 15, 2006. http://knowledge.wpcarey.asu.edu/article.cfm?articleid=1207.

Brookhaven National Laboratory. *Laboratory Directed Research and Development (LDRD).* February 12, 2014. http://www.bnl.gov/ldrd/.

Center for Integrated Nanotechnologies. *About Us.* 2009. http://cint.lanl.gov/source/orgs/mpa/cint/about_us.shtml.

—. *Spring 2014 - Call for User Proposals.* 2014. http://cint.lanl.gov/user_call/index.shtml.

Davidsen, Jörn, Holger Ebel, and Stefan Bornholdt. "Emergence of a small world from local interactions: Modeling acquaintance networks." *Physical Review Letters* 88, no. 12 (2002).

Drexler, Eric K., John Randall, Stephanie Corchnoy, Alex Kawczak, and Michael L. Steve. "Productive nanosystems: A technology roadmap." 2007. http://e-drexler.com/productivenanosystems/docs/Nanotech_Roadmap_2007_main.pdf.

Gibson, James N. *Complete List of All U.S. Nuclear Weapons.* . October 14, 2006. http://nuclearweaponarchive.org/Usa/Weapons/Allbombs.html.

Gronlund, Lisbeth. *Penny Wise & Pound Foolish: Cuts to Basic Science at the Weapons Labs.* October 18, 2013. http://allthingsnuclear.org/penny-wise-pound-foolish-cuts-to-basic-science-at-the-weapons-labs/.

Ham, Rose Marie, and David C. Mowery. "Improving the effectiveness of public-private R&D collaboration: case studies at a US weapons laboratory." *Research policy* 26.6 (1998): 661-675.

Kenny, Barbara, interview by Tim Arnold. (April 2, 2014).

Knispel, Sandra. "What national labs and universities get out of collaboration:." *MPB News.* November 12, 2012.

http://mpbonline.org/News/article/421mississippis_universities_collaborate_with_national_labs.

Korman, Can, interview by Christina Walrond. (March 2014).

Kreuter, Nate. *Salary Realities.* September 5, 2012. http://www.insidehighered.com/advice/2012/09/05/essay-what-new-faculty-members-need-know-about-salaries (accessed April 20, 2014).

Martin, Travis, Brian Ball, Brian Karrer, and M. E. J. Newman. "Coauthorship and citation in scientific publishing." (arXiv preprint:1304.0473) 2013.

Miller, Chris. "LDRD Program avoids budget cut." *SANDIA LAB NEWS.* February 7, 2014. http://www.sandia.gov/news/publications/LabNews/archive/_assets/documents/labnews02-07-14.pdf.

Mora, Carl J. "Sandia National Laboratories: The First Fifty Years." November 1999. http://www.osti.gov/scitech/servlets/purl/14378.

Moreno, Dr. Yolanda, interview by Linda George. *Campus Executive Program* (March 2014).

National Academy of Public Administration. "Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories ." *National Academy of Public Administration.* January 2013. http://www.napawash.org/wp-content/uploads/2013/01/DOE-FINAL-REPORT-1-2-13.pdf.

National Research Council. *National Laboratories and Universities: Building New Ways to Work Together -- Report of a Workshop.* Washington, DC: The National Academies Press, 2005.

National Science Foundation. "Revised NSF Merit Review Criteria." *National Science Foundation.* January 2014. http://www.nsf.gov/bfa/dias/policy/merit_review/overview.pdf (accessed March 30, 2014).

Newman, Mark EJ. "Clustering and preferential attachment in growing networks." *Physical Review* E 64.2 (2001).

Nuclear Watch New Mexico. *Compilation of NNSA FY 2014 Budget Request.* April 13, 2013. http://nukewatch.org/economics/FY2014_NNSA_Budget_4-10-13_Print.pdf.

Office of Science. "Legislative History of the LDRD Program." *U.S. Department of Energy.* http://science.energy.gov/~/media/lpe/word/LDRD-Legislative-History-07-01-2011.docx.

Phillips, Dr. Julia, interview by Tim Arnold. (March 19, 2014).

Rottler, J. Stephen. *The Importance of the National Laboratories.* April 19, 2012. http://media.elliott.gwu.edu/media/importance-national-laboratories.

Saini, Rajiv, Santosh Saini, and Sugandha Sharma. "Nanotechnology: The future medicine." *Journal of cutaneous and aesthetic surgery* 3, no. 1 (2010): 32–33.

Sandia National Laboratories. *Laboratory Directed Research & Development.* 2014. http://www.sandia.gov/research/laboratory_directed_research/.

—. *Mission.* 2014. http://www.sandia.gov/about/mission/index.html.

—. *University Partnerships.* 2014. http://www.sandia.gov/working_with_sandia/technology_partnerships/universities/index.html.

Shinn, Dr., interview by Linda George. (March 2014).

Stoll, Dr. Sarah, interview by Tim Arnold. (March 18, 2014).

WORKS REFERENCED

"ASU Lightworks, Sandia Partner to Tackle Renewable Energy Challenges," ASU News, August 30, 2013.

Bardet, Dr. Philippe, Assistant Professor of Engineering and Applied Science, GW, interview by Christina Walrond. (March 19, 2014).

Cahill, Dr. Chris, Professor of Chemistry, George Washington University, interview by Christina Walrond. (March 19, 2014).

Carayannis, Elias, Jeffrey Alexander, and Anthony Ioannidis, "Leveraging Knowledge, Learning, and Innovation in Forming Strategic Government–University–Industry (GUI) R&D Partnerships in the US, Germany, and France," Technovation 20 (2000): 477.

"Center for Nanophase Material Science," Oak Ridge National Laboratory, accessed February 3, 2014, http://www.cnms.ornl.gov/about_cnms/CNMS_Fact_Sheets.pdf.

"Center for Nanoscale Materials," Argonne National Laboratory, accessed January 14, 2014, http://nano.anl.gov/.

"Chapter 6 – Federal Technology Transfer," Georgetown University, accessed February 13, 2014, http://kie.georgetown.edu/nrcbl/documents/dnapatents/HGPPatDNACh6.pdf. on technology transfer.

"CINT: Center for Integrated Nanotechnologies," accessed January 13, 2014, http://cint.lanl.gov/.

"Collaboration of UT, ORNL, and Sandia Researchers Published in Science," University of Tennessee, accessed January 27, 2014 http://www.engr.utk.edu/news/releases/gong_gu_pub2014.html.

"Collaborations and Funding," National Nanotechnology Initiative, accessed February 4, 2014, http://www.nano.gov/initiatives.

Delgato, Steve, "UA, Sandia Laboratories to Partner on Environment Research," UA News, May 24, 2011.

Dooley, Lawrence and David Kirk, "University-Industry Collaboration: Grafting the Entrepreneurial Paradigm onto Academic Structures," European Journal of Innovation Management 10 (2007): 316.

"Economic Stimulus: Technology Transfer from Federal Labs," American Chemical Society Science and Congress Project, July 27, 2012.

"Federal Laboratory Technology Transfer: Report to the President and Congress," prepared by the National Institute of Standards and Technology, U.S. Department of Commerce, August 2012.

Geuna, Aldo. "Determinants of university participation in EU-funded R&D cooperative projects." Research Policy 26, no. 6 (1998): 677-687.

Guggisberg, Martin, Peter Fornaro, Tibor Gyalog, and Helmar Burkhart. "An interdisciplinary virtual laboratory on nanoscience." Future Generation Computer Systems 19, no. 1 (2003): 133-141.

Ham, Rose Marie, and David C. Mowery. "Improving the effectiveness of public-private R&D collaboration: case studies at a US weapons laboratory."Research policy 26, no. 6 (1998): 661-675.

Hommert, Paul, "Technology, Policy, and National Security," (speech, Washington, DC, September 10, 2013), The Elliott School of International Affairs, http://media.elliott.gwu.edu/media/technology-policy-national-security.

Improving Technology Transfer at Universities, Research Institutes, and National Laboratories: Hearing Before the Subcommittee on Research and Technology in the Committee on Science, Space, and Technology, United States House of Representatives, One Hundred and Thirteenth Congress, First Session, July 24, 2013, 113th Cong., (2013).

Johnson, Dexter. *Multidisciplinary Nature of Nanotechnology Confirmed.* September 8, 2009. http://spectrum.ieee.org/nanoclast/semiconductors/nanotechnology/multidisciplinary-nature-of-nanotechnology-confirmed.

Jeschke, Sabina, Uwe Sinha, and Christian Thomsen. "Collaborative working environment f or virtual and remote experiments in nanoscience and nanotechnologies." (2006): 2055-2060.

Katz, J. Sylvan and Ben R. Martin, "What is Research Collaboration," Research Policy 26 1997) 1.

"Lab Directed Research and Development – Annual Report," Sandia National Laboratories, March 2013.

Lane, Neal. "The grand challenges of nanotechnology." Journal of Nanoparticle Research 3, no. 2-3 (2001): 95-103.

"Nanoscience and Nanotechnology at PNNL," Pacific Northwest National Laboratory, accessed February 4, 2014, http://www.pnnl.gov/nano/.

National Research Council. National Laboratories and Universities: Building New Ways to Work Together -- Report of a Workshop. Washington, DC: The National Academies Press, 2005.

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick. *Beyond sputnik: US science policy in the twenty-first century.* Ann Arbor: University of Michigan Press, 2008.

Pertuze, Julio, Edward Caldor, Edward Greitzer, and William Lucas, "Best Practices for Industry-University Collaboration," MIT Sloan Management Review 51, no. 4 (2010): 83.

"Positioning DOE's Labs for the Future: A Review of DOE's Management and Oversight of the National Laboratories," National Academy of Public Administration, January 2013, http://www.napawash.org/wp-content/uploads/2013/01/DOE-FINAL-REPORT-1-213.pdf.

"Research Universities and the Future of America," National Research Council of the National Academies, 2012, http://www.federalrelations.wisc.edu/docs/FutureofAmericaU.pdf.

Santoro, Michael D., and Alok K. Chakrabarti. "Building industry–university research centers: some strategic considerations." international Journal of management reviews 1, no. 3 (1999): 225-244.

Stepp, Matthew, Sean Pool, Nick Loris, and Jack Spencer, "Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy," The Information Technology and Innovation Foundation, The Center for American Progress, and The Heritage Foundation, June 2013.

Stricker, Nicole. "National labs collaborate with academia to design accident-tolerant nuclear fuel." https://inlportal.inl.gov/portal/server.pt/community/newsroom/257/feature_story_details 1269?featurestory=DA_589339.

Turner, James. "Best Practices in Merit Review ." *Association of Public and Land-grant Universities.* December 2010. http://www.aplu.org/document.doc?id=2948 (accessed April 20, 2014).

"University Partnerships – Annual Report," Sandia National Laboratories, June 2010.

"Vermont-Sandia Partnership," University of Vermont, accessed February 17, 2014, http://www.uvm.edu/~vtsandia/.

Wentworth, Karen, “UNM, Sandia National Laboratories Sign Agreement to Allow Closer Collaborations,” UNM Newsroom, January 17, 2014.

Wessner, Charles, ed. A Review of the Sandia Science and Technology Park Initiative. National Academies Press, 1999.

Wessner, Charles W. New York's Nanotechnology Model: Building the Innovation Economy: Summary of a Symposium. National Academies Press, 2013.

Wilmoth, Adam, “University of Oklahoma, Sandia Labs Partnership to Boost Research,” NewsOK, December 11, 2013.

Worrall, Dr. Andrew, Senior Reactor Design and Analysis Engineer at Oak Ridge National Laboratory, interview by Christina Walrond. (March 19, 2014).