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The 2020 G. Robert Keepin Nonproliferation Science Summer Program: A Virtual Success Story during the COVID-19 Pandemic

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ABSTRACT

In 2017, Los Alamos National Laboratory (LANL) and the Nuclear Science and Security Consortium (NSSC) jointly established the G. Robert Keepin Nonproliferation Science Summer Program, named in honor of the father of nuclear safeguards. The Keepin Program annually brought a cadre of graduate and undergraduate students, largely from National Nuclear Security Administration (NNSA)-funded university consortia, to LANL for 8 weeks. The Program traditionally featured a research internship complemented by lectures and tours to provide exposure to the LANL mission space. A total of 79 undergraduate and graduate students have participated in the Program since it was established in 2017, 39% of whom have continued making their careers at LANL.

During the summer of 2020, the COVID-19 pandemic presented challenges for the Laboratory's summer school programs. While many of LANL's annual schools opted to forgo the 2020 summer, the Keepin Program organizers felt that students would still benefit from the high-quality lectures and a world-class internship experience, even remotely. This vision was successfully achieved through modifications to the Keepin Program, accommodating a virtual experience while maintaining as many components of the Program as possible. The traditional format includes a research internship and weekly activities that aim to provide exposure to the nonproliferation mission space through lectures, hands-on training, and technical tours. All 18 lectures were delivered via WebEx, and the program organizers were able to offer additional seminars, informal Q&A discussions, and ice breaker activities due to the flexibility of remote engagement. Although students were not able to travel on site, Keepin students were granted permission to complete their internships through access to tools and resources required by their projects. Ultimately, the students who participated in first virtual Keepin Program were able to work with LANL scientists and learn about nonproliferation applications for their skills. 100% of students were likely to recommend the program to others, and 90% were more likely to consider careers in nonproliferation. Although the 2020 Keepin Program looked very different from previous years, the virtual experience upheld the program's reputation for excellence and for strengthening the pipeline of students interested in contributing to the nonproliferation mission space.

TRADITIONAL FORMAT

The traditional Keepin format consists of eighteen lectures given at LANL for the 8-week's duration during the summer. The topics introduced to students range from data analytics to reprocessing safeguards to an introduction to nuclear weapons, all selected based on relevance to nuclear nonproliferation. Lectures took place nearly every Monday and Wednesday of the summer, allowing for students to spend the rest of their weeks on project work for their laboratory mentor. A complete list of technical lectures given at LANL in 2019 is included below.

Table 1: Lectures offered during the traditional Keepin Program during the 2019 summer

Overview of International Safeguards	Nuclear Policy & Deterrence Issues
Cosmic Ray Muon Radiography for Special Nuclear Material Detection	Nuclear Deterrence and Vigilance: Space-Based Explosion Monitoring
Destructive Analysis Technology Overview	Reactor and Spent Fuel Safeguards
The Radiological Triage Program	Data Analytics for Nonproliferation
Fuel Fabrication Safeguards, Reprocessing Safeguards Instrumentation	Computational Modeling and Simulation for Nonproliferation
A Case Study in Counterintelligence v	Non-Destructive Assay Technology Overview
Nuclear Smuggling, Detection, and Deterrence Program	National Security Through Radioactive Source Removal
Proliferation Footprints: Hydrotesting Around the World	Small Special Purpose Nuclear Reactors for Government Use
Arms Control Tabletop Exercise	History of the Laboratory

The lectures throughout the summer were supplemented by tours of the unique facilities at LANL and Sandia National Laboratory (SNL). A list of the Los Alamos tours is included below.

Table 2: Tours offered during the traditional Keepin Program during the 2019 summer

Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT)
Supercomputing Complex
Los Alamos Neutron Science Center (LANSCE)
Space Detection Instruments Laboratory
Bradbury Science Museum
Harvester Laboratory (Sandia)
Annular Core Research Reactor (Sandia)
Gamma Irradiation Facility (Sandia)
Microsystems Engineering, Science, and Applications Fabrication Facility (Sandia)

Students also had the opportunity to spend two full days at Sandia National Laboratory and attend a series of tours, talks, and hands-on exercises.

The traditional Keepin Program features two optional activities that are open to the students. The first is a week-long training course on nondestructive assay (NDA) techniques that occurs before the official start of the program. This LANL course, which has been used to train every International Atomic Energy Agency (IAEA) inspector since 1980, was designed to provide trainees with hands-on experience in performing neutron and gamma measurements of special nuclear material.

The second unique opportunity for the students is to participate in an optional trip to the Nevada National Security Site's (NNSS) Device Assembly Facility (DAF). The DAF trip gives students the chance to participate in an experiment using NCERC's stores of special nuclear materials used for research and training, hear presentations and demonstrations about critical and subcritical experiment design, execution, and measurements, and visit the Sedan Crater, formed in 1962 during an excavation experiment using a 104-kiloton thermonuclear device.

Finally, the traditional Program format features an extended research internship to provide broad exposure to the LANL mission space. It also aims to increase the number of students performing lab-directed research with LANL as a part of their doctoral dissertations and ultimately turn research and training into careers at the national laboratories. The goal of the Program is to create long-lasting working relationships between students and LANL scientists, to increase the number of students performing lab-directed research with LANL, and ultimately to turn research and training into careers at the national laboratories.

MODIFICATIONS TO THE TRADITIONAL FORMAT

In order to reduce the risk of transmission of COVID-19 to Keepin Program participants, staff, mentors, lecturers, and seminar speakers, modifications to the traditional Keepin Program were made to promote social distancing and operate primarily in a remote work mode, while maintaining as many key components to the traditional Keepin format as possible. The Keepin Program could accommodate remote lectures with relatively little change to Program structure. Using the WebEx video conferencing forum, speakers adhered to the usual Monday/Wednesday schedule and logged into the tool at the appointed lecture time. Students were required to participate in each lecture offered and had the opportunity to interact with speakers via the chat feature or by directly asking questions.

Students and mentors were instructed to establish a communication plan in advance of the Program to determine the frequency of WebEx meetings and to discuss project status, obstacles encountered, and upcoming deliverables. All additional interaction was carried out through e-mail exchanges as necessary. Students were required to submit a weekly work progress form to their mentors. Mentors tracked individual student participation and progress on tasks assigned, and they communicated any concerns to Keepin staff.

Access to LANL capabilities, including high performance computing resources, was granted in order for students to connect with mentors and to produce high-quality work, just as in a regular in-person internship.

The table below offers a summary of the differences between the virtual program and the program offered via the traditional format.

Table 3: Differences between traditional on-site format and remote format

Traditional On-Site Format	Summer 2020 Remote Format
Educational Components 1. Lectures a. Program Introduction (30 min) b. History of the Lab (1 hour) c. Overview of International Safeguards (1 hour) d. NDA Technology Overview (30 min) e. DA Technology Overview (30 min) f. Reactor and spent fuel safeguards (1 hour)	*Educational Components* 1. All lectures listed to the left were performed via WebEx 2. All professional development seminars, discussions, and activities listed to the left were performed via WebEx

g. Fuel fabrication safeguards, reprocessing safeguards instrumentation (1 hour) h. Nuclear deterrence and vigilance: space-based explosion monitoring (1 hour) i. Nuclear smuggling, detection and deterrence program (30 min) j. The radiological triage program (1 hour) k. National security through radioactive source removal (30 min) l. Small special purpose nuclear reactors for government use (1 hour) m. A case study in counterintelligence (1 hour) n. Nuclear policy issues and deterrence (30 min) o. Nuclear weapons 101 (1 hour) p. Computational modeling and simulation for nonproliferation (1 hour) q. Data analytics for nonproliferation (1 hour) 2. Professional Development a. Early career panel and Q&A (1 hour) b. Student research presentation (4 hours)	
Research Components Students perform research under a LANL scientist on a project of the scientist's choosing and will be funded directly by the lab PI. Our goal is to identify mentors with research activities that align with the students' research interests and academic goals with the intention of using this experience as a stepping-stone towards long-lasting relationships and future collaborative research. At the end of the internship students will prepare posters to present to fellow students summarizing the research project.	*Research Components* The research component of the internship can be carried out by providing students with appropriate tools to work remotely. The final project presentation was given via WebEx.
Technical Enrichment Components 1. Tours of facilities across the laboratory. Past tours have included : a. Bradbury Museum b. Sandia National Laboratories c. LANSCE d. DARHT e. HPC f. DAF trip 2. Laboratories a. Gamma measurements	*Technical Enrichment Components* 1. Onsite tours are cancelled, reading material about certain facilities (LANSCE, DARHT) could be provided to students 2. New activities were developed to simulate laboratory exercises

b. Neutron measurements	
Feedback Overall Program evaluation (completed by each student at the end of the program)	*Feedback* Remote evaluation form will be provided

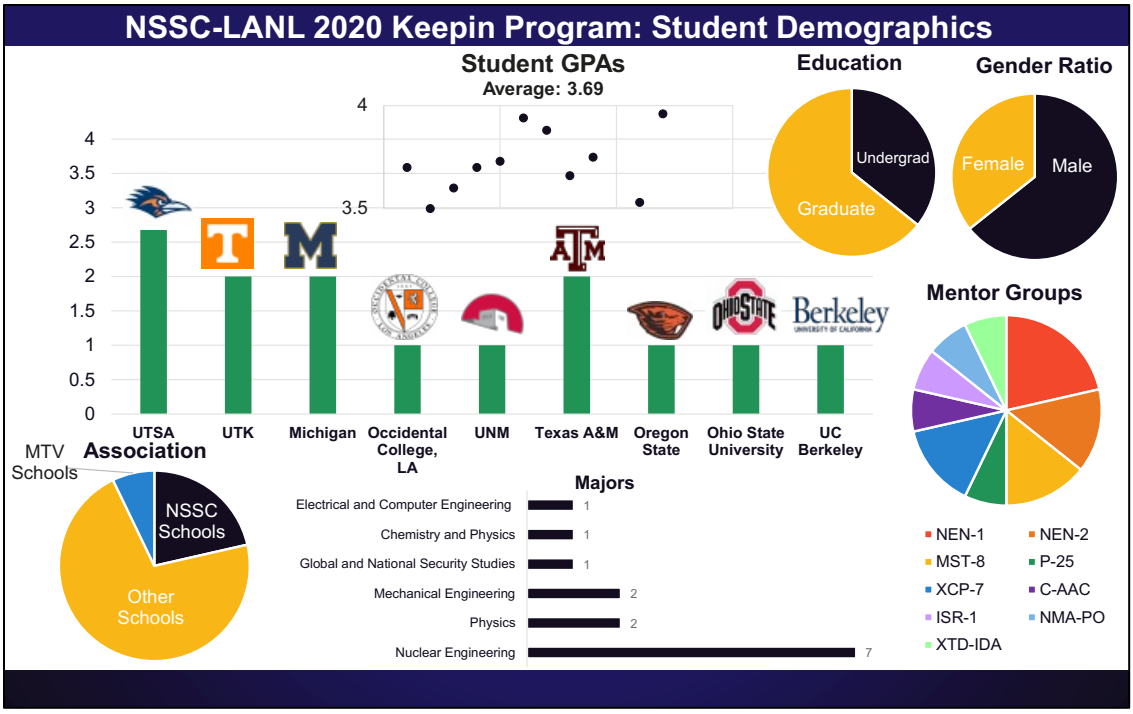

Figure 1: 2020 Keepin Student Demographics.

PROGRAM ASSESSMENT

As in previous years, feedback from Program participants was collected on a weekly basis in addition to a final survey conducted at the end of the Program. Ultimately, the 13 students who participated in first ever virtual Keepin Program enjoyed the opportunity to work with LANL scientists and learn about the variety of nonproliferation applications for their skills. 100% of students were likely to recommend the program to others (Fig.2), and 90% were more likely to consider careers in nonproliferation across the Department of Energy (DOE) complex (Fig.3). The delivery and content of all presentations averaged excellent ratings: over 4.5 out of 5. The aggregate survey results from each talk in 2020 is included below (Fig.4).

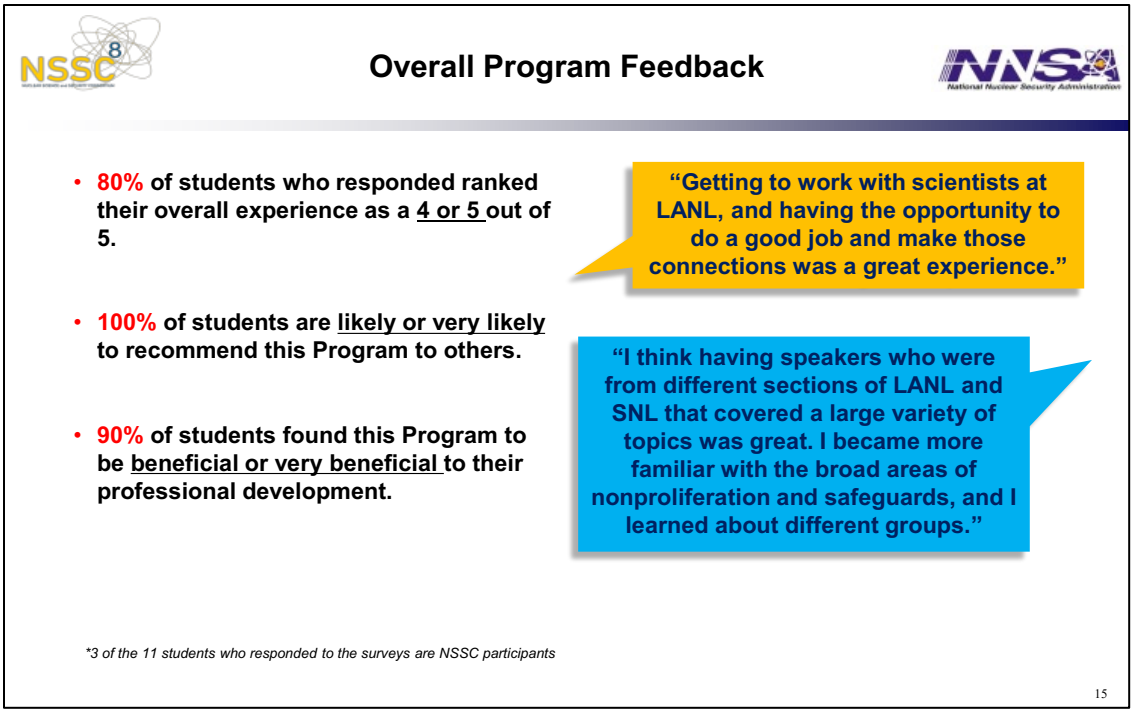

Figure 2: Overall Program Feedback

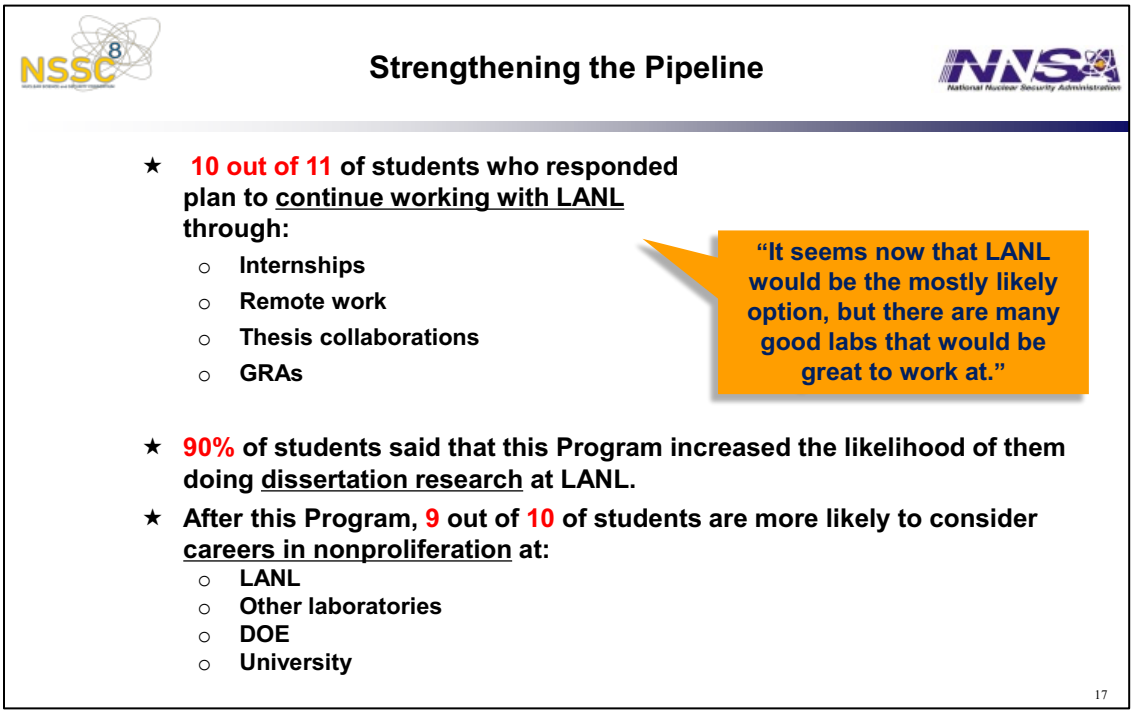

Figure 3: Strengthening the Pipeline

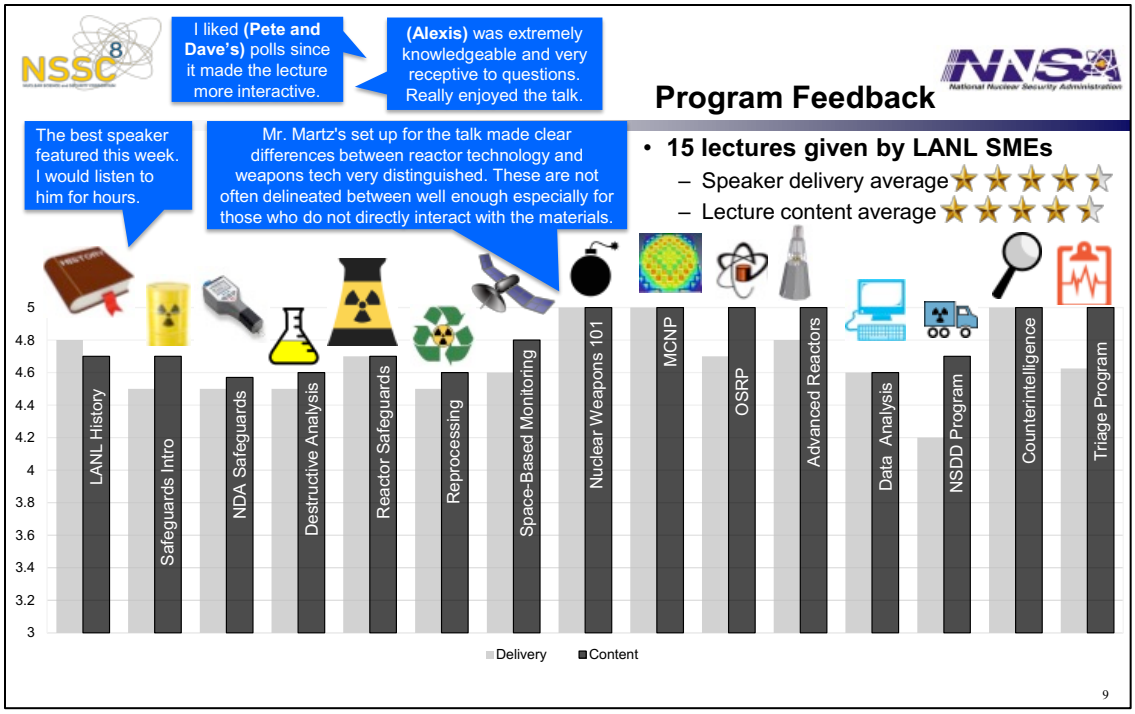

Figure 4: Program Feedback

CONCLUSION

The 2020 Keepin Program presented a new challenge for both students and organizers. While many of LANL's summer schools chose to cancel their activities in the face of a global pandemic, the Keepin team felt that it was important to virtualize the flagship program and continue to invest in nonproliferation education. The program needed to be adapted and changed in a relative short amount of time, and mentors had to connect with their students in a virtual environment, forgoing face-to face interaction and often overcoming connectivity issues. Exploring different remote platforms and training program staff quickly became part of the new normal, and the skills honed in virtual environments have continued to benefit the 2021 Keepin Program and other work across the laboratory. Even in a nontraditional format, the success of the 2020 Keepin Nonproliferation Science Summer Program was a testament to the strength of the LANL-NSSC partnership and the flexibility of the planning team. Mentors were able to design valuable projects to be conducted remotely, and the students were still enthusiastic about the quality of the lectures provided. As future iterations of the program transition back into an in-person format, it is encouraging to note that the 2020 cohort of Keepin students was very much interested in pursuing careers at LANL and in the nonproliferation mission space – all due to a positive virtual experience.

ACKNOWLEDGEMENTS

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