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The Nonproliferation Mentorship Program at Sandia National Laboratories

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Roadmap

Introduction

History & Development

NMP Today

Evidence of NMP Success

NMP Next Steps

Introduction

- Increasing *complexity in global security* landscape:
  - Quickly shifting geopolitical environments
  - Rapidly changing technological (r)evolution
  - Increasing pressure through privatized development/manufacturing capabilities
  - Advanced/diversifying threat capabilities.
- Nonproliferation to reduce the risk of WMD use → technical, political, & historical challenges
- These challenges → robust and resilient HCD solutions
  - Coordinate various interdependencies and sensitivities
  - Combine lessons from the past with innovative, state-of-the-art thinking
- The need → new cadres of professionals to address the *drivers, dynamics, decisions,* & *designs* in reducing global WMD-related risks

History & Development

- Designed on success of Sandia's *Weapons Intern Program*
- Leveraged key Sandia capabilities:
  - Deep cadre of related experts
  - Wealth of "on-the-ground" experience
  - Access to unique NP insights from stockpile programs
- Goal: teach the next generation "*how to do right things*"
- 2000s:
  - Develop graduate-level course
  - Partner with UNM to deliver course
- 2010s:
  - Refine course, update materials
  - Expand course participants
- 2020s:
  - Develop current 2-phase structure
  - Expand course participants

NMP Today: Phase I

- Complete graduate-level course
  - *Weapons of Mass Destruction (WMD) Non-Proliferation Science and Policy*
  - Traditionally cross-listed at UNM:
    - Political science
    - Nuclear engineering
    - Chemical engineering
- Curriculum better coordinates, emphasizes points of intersection, & identifies common patterns in WMD proliferation
  - History
  - Policy
  - Technology
  - Practicality
- WMD proliferation-related topics are taught by subject matter experts who serve as guest lecturers

Module 1 Course Overview and WMD Non-proliferation Challenges

- *Course Overview (PI)*
- *WMD Non-proliferation Problems, Challenges, and Issues (PI*)*

Module 2 Introduction to Analytical Frameworks

- *Critical Thinking Concepts (PI)*
- *Systems Approach and Scientific Method: Technical Frameworks (PI)*
- *Analytical Methodologies (SME**)*

Module 3 Overview of WMD Threats and Technical Issues

- *Chemical Weapons: History, Terminology, Technology, and Conventions (SME)*
- *Biological Weapons: History, Terminology, Technology, and Conventions (SME)*
- *Nuclear Energy: History, Terminology, and Technology (PI)*
- *Nuclear Weapons: History, Terminology, Technology, and Nuclear Fuel Cycle-(PI)*
- *WMD Delivery Systems (SME)*

Module 4 Current Approaches to Threat Reduction

- *Historical Efforts to Control the NFC and Introducing Integrated Nuclear 3S Concept (PI)*
- *Nuclear Security and the Convention on Physical Protection of Nuclear Materials (SME)*
- *The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the International Safeguards Regime (SME)*
- *Arms Control History and Theories (SME)*
- *Nuclear Deterrence History and Theories (SME)*

Module 5 Current Challenges

- *Nuclear Tipping Point (PI)*
- *Current NPT Challenges: The Middle East resolution to establish a WMD Free Zone in the Middle East (PI)*
- *Non-Compliance: Iran and North Korea. What are Potential Regional Impacts? (PI)*
- *Lessons Learned from Nuclear Nonproliferation Successes. Case studies: South Africa, Libya, Iraq, South Korea and Taiwan. Back to the future? (PI)*
- *Nuclear Terrorism: How Real is the Threat? (SME)*

Module 6 Addressing the Challenges

- *Conflict Management: Track I/II, Think Tanks, and NGOs (SME)*
- *Risks Associated with the Global Expansion of Nuclear Energy (PI)*
- *Reducing Motivations: Connectivity Hypothesis, Discussion and Exercise (SME)*
- *Nuclear Disarmament Verification Exercises (SME)*

NMP Today: Phase II

- Goal: apply a part of the knowledge from Phase I to real-world WMD proliferation-related problem
  - Taken from the success of a similar element for the Fundamentals Course of the Gulf Nuclear Energy Infrastructure Institute
- Capstone projects support knowledge transfer:
  - Opportunities to demonstrate increased depth of understanding and analytic capacity related the WMD proliferation
  - Primary mechanism by which participants engage with their subject matter expert mentors
  - Can generate a range of potential solutions to current (and anticipated) WMD proliferation-related problems
- NMP Symposium → Phase II research shared & discussed with a broader audience of interested experts, line managers, and upper-level Sandia leadership

2016

- *The Motivations of Iran to Develop Nuclear Weapons*
- *Pakistan and India conflict*
- *A way to approach nuclear non-proliferation with a state; diplomacy and building trust*

2017

- *Has the U.S. violated article VI of the NPT?*
- *The Threat of Delivery System Proliferation*
- *Radiological Risks from Commercial Quantities of Concern*
- *Proposal for Monitoring Within the Centrifuge Cascades of Uranium Enrichment Facilities*
- *The Effectiveness of the Joint Comprehensive Plan Of Action (JCPOA) Post Implementation*

2018

- *Evolution of Optical Sensors for NUDET Detection*
- *The Organization for the Prohibition of Chemical Weapons – Counteracting the New Threats from Non-State Actors*
- *A Deterrence Stability Framework*
- *IAEA Safeguards and Verification Methods*
- *U.S. Policy and the Weakening of the Nonproliferation Regime*

2019

- *China's Belt and Road Initiative: Shifting Economic and Political Influence in the Gulf Cooperation Council States*
- *Unintended Impacts of the Export Control Reform Act*
- *Sanctions and Non-Proliferation*

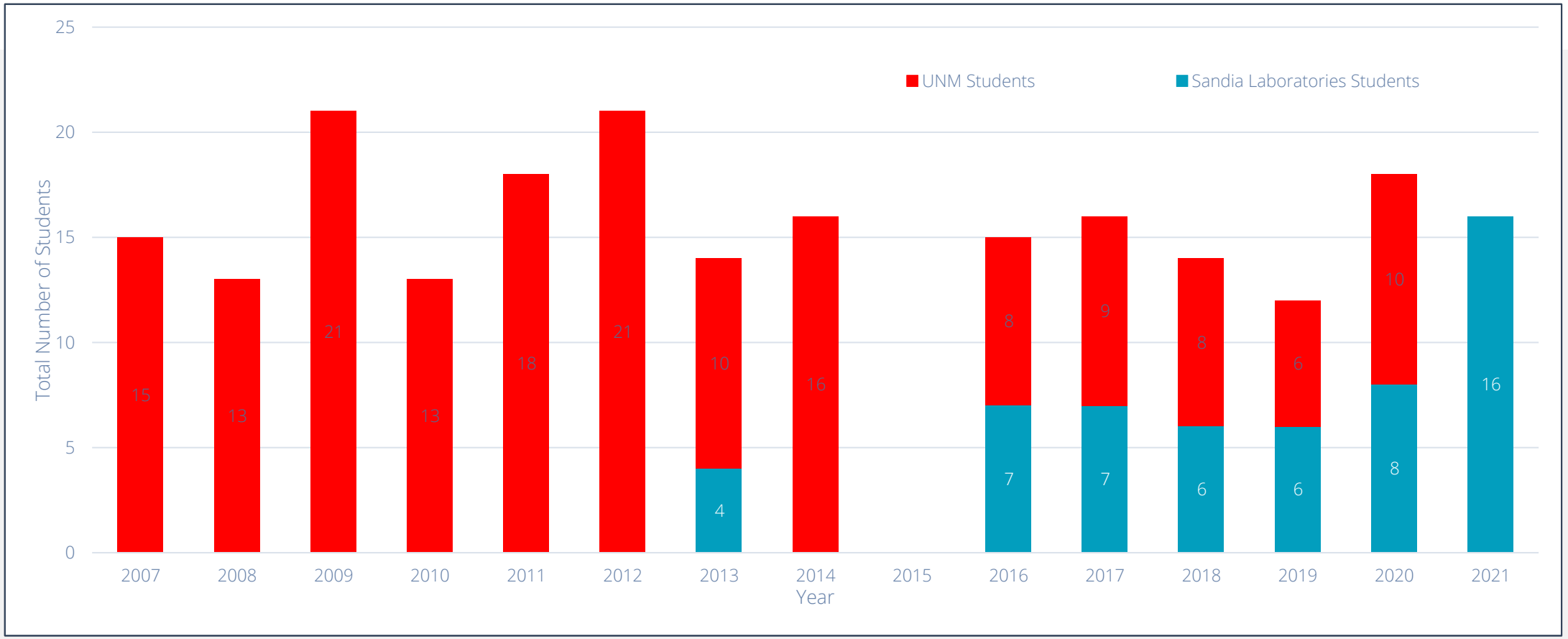
2020

- *Risk Reduction in South Asia: How Multilateral Can it Get?*
- *Is a Cyber Treaty Possible?*
- *Analyzing ABACC as a System and Understanding it's Potential Applications*
- *Integrating Human Centered Design Considerations into Physical Protection Systems*
- *Novel framework of US and Global Regimes to Counter Infectious Diseases*

2021*

- *Data-Driven Treaty Verification: A Combined Systems-Based Modeling Approach*
- *Lessons Learned from the BWC's Shortcomings & Successes: Implications for the Nuclear Domain*
- *3S Analysis for Small Modular Reactors*
- *Safeguards Inspections Prioritization Methodology*

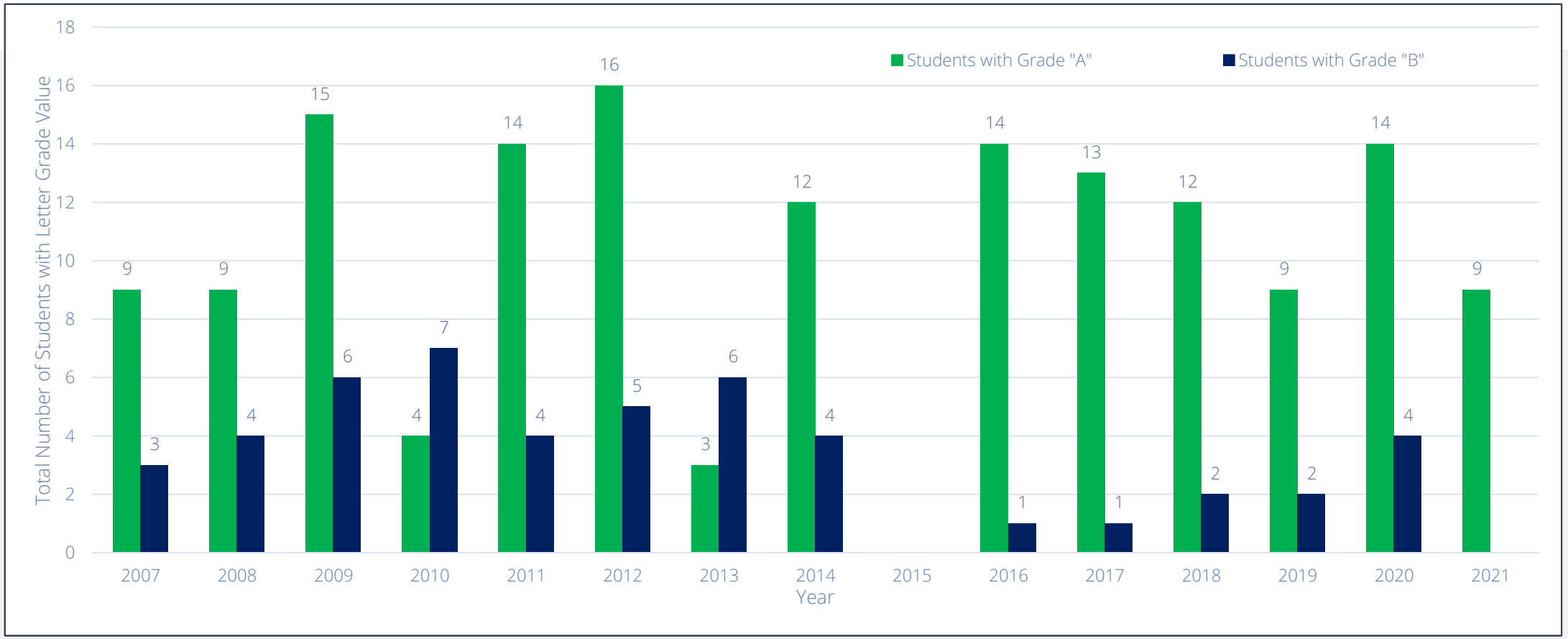
Evidence of NMP Success



- Consistent participation from Sandia professionals over the course's existence, as well as fairly consistent participation from UNM students

- This sustainment enrollment suggests that both students and working professionals saw value in this element of the NMP and serves as a proxy measure of success

Evidence of NMP Success



- Results → high degree of knowledge transfer being experienced in the course
  - *Could reflect* the benefits of the structure, curriculum, and ethos of the course to successfully transfer WMD proliferation-related knowledge
  - *Could reflect* the high caliber of participant attracted to the NMP who helped craft a classroom environment that enhanced knowledge transfer

Evidence of NMP Success

The NMP allowed me to expand my knowledge related to WMD and nonproliferation. This course helped enhance my professional career and understand how the physical security of nuclear material reduces the risk of proliferation and potential for WMD creation

Senior nuclear engineer in international nuclear security

Senior chemist in chemical weapons security & nonproliferation

I participated in the NMP as an early career chemical nonproliferation professional and left with a clear view of the entire nonproliferation landscape. I learned many foundational tenets of nonproliferation that would have taken years to acquire organically through my work. The entire program…deepened my ability to think critically and generate original solutions. The instructors were excellent, freely shared their bounties of knowledge, and provided access to renown subject matter experts. My professional network has grown significantly thanks to participation in this program and my visibility into potential career opportunities has widened. I'm thankful I was able to participate!

As an experienced biologist with some familiarity of the history and current non-proliferation efforts involving biological and chemical weapons, I knew that the [NMP] course would likely greatly expand my knowledge on nuclear non-proliferation history and status of current treaties, which it truly did. What surprised me, however, was that as a published author of dozens of scientific articles, I learned so much on translating the use of the scientific method into persuasive oral and written arguments. The class really honed my skills as a critical reader, speaker, author and presenter

Senior engineering program lead in biosafety & biosecurity

Evidence of NMP Success

Although I had ten years of industry experience in space and ground systems, I lacked insight into the history, politics, and science of WMDs and related treaties. The NMP provided me with an opportunity to dive into the context behind nuclear non-proliferation. The combination of the course work and capstone project through NMP helped solidify the connection between academic knowledge and the mission work I supported. This context continues to serve me well in my career

Research & Development manager in distributed sensing systems mission engineering

The Nonproliferation Mentoring Program…course encourages broad-minded critical thinking and new idea generation. It gave me an understanding of the mission space that otherwise would have taken me years to gain

Senior project controller and business management professional

- Approximately 25% of students who took the course decided to continue their education into a NP-related field
- Another 10% of students changed their career paths to seek employment into nonproliferation-related fields
- Past participants have become nonproliferation advisors for U.S. national security agencies

NMP Next Steps

- Recent NMP successes → established a strong reputation for the program

- Several areas for potential program expansion:
  - Identify additional university partners → increase academic rigor & reach
  - Develop new academic credentials → university-based vs. professional development?
  - Evaluate hybrid education models →lessons from COVID-19 to increase flexibility
  - Broaden NMP participation → more diversity enhances the educational experience

- Goal(s) of all planned and potential next steps:
  - Enhance NMP ability to produce high quality experts
  - Support a broader set of stakeholders (NNSA, DOS)
  - Better prepare next generation to tackle tomorrow's WMD proliferation challenges