



**STRATEGIC DETERRENCE  
& GLOBAL RESILIENCE:**

# **ADVANCING INTEGRATED READINESS**

**BIENNIAL REPORT**

July 1, 2022 - June 30, 2024



**NSRI**  
**NATIONAL STRATEGIC  
RESEARCH INSTITUTE**  
*at the University of Nebraska*

# Table of Contents

## FOREWORD

- 1 Message from the Executive Director

## INTRODUCTION

- 2 Agile Strategies for a Multi-Domain World
- 7 Impact Metrics

## RESEARCH IMPACT

- 8 Research for Mission Impact
- 9 Focus Area Highlights
- 14 Countering Nascent Threats: Foresight for Tailored Solutions
- 17 Contributing to Real-World Strategies: Thought Leadership for Actionable Outcomes
- 20 Activating Decisive Action: Rapid Response to Real-Time Challenges
- 23 Supporting Command Strategy: Optimized Data & Skills for Efficient Decision Making

## COLLABORATION

- 26 Leadership
- 27 Principal Investigators & Contributors
- 28 NSRI Fellows
- 30 Students of NSRI
- 32 Cultivating Innovation
- 34 Expanded Facilities & Capabilities
- 36 Contracting & Business Process

## NSRI MISSION STATEMENT

**Provide novel research, technology, training and expertise to improve the U.S. capability to deter, interdict and respond to strategic threats.**

*Front Cover, Top Right: NSRI strategic deterrence interns with Brig. Gen. William Murphy (center left) following the interns' final briefing at USSTRATCOM headquarters, Offutt Air Force Base, Omaha, Nebraska, August 2023.*

*Front Cover, Bottom Right: Grant Phillips, graduate student in the School of Computing at the University of Nebraska–Lincoln (UNL), works on a drone in the UNL Nebraska Intelligent MoBILE Unmanned Systems Laboratory.*

*Front Cover, Bottom Left: NSRI Fellow Dr. Melissa Wuellner, associate professor of biology at the University of Nebraska at Kearney, at the bench in her lab. Dr. Wuellner's research interests include human dimensions of wildlife and fisheries, systems thinking and systems dynamics and more.*

*Front Cover, Top Left/Back Cover, Top Right: Marty Sikes (left), NSRI associate executive director, attaches a nebulizer cup to a custom aerosol generator to prepare for a tracer release. On board USNS Mercy, February 2024. Photo credit: ENS Lacy Burkett, assistant public affairs officer.*

*Inside Cover, Left: NSRI researchers evaluate improved thermal oxygen lances to rapidly breach steel barriers.*

*Back Cover, Top Left: University of Nebraska at Omaha researchers attach sensors during demonstration of the Department of Biomechanics' state-of-the-art motion capture analysis system.*

*Back Cover, Bottom: NSRI Fellow Dr. Rebecca Oberley-Deegan (right), professor in the department of biochemistry and molecular biology at the University of Nebraska Medical Center, consults with a student in her lab. Dr. Oberley-Deegan's lab contributes to one of NSRI's largest projects.*



## MESSAGE FROM THE

# EXECUTIVE DIRECTOR

Though the work of the National Strategic Research Institute (NSRI) at the University of Nebraska (NU) seems complex, its value over the two years covered by this report is seen in simplicity — respond, advance, deliver. As a University Affiliated Research Center (UARC), designated by the U.S. Department of Defense (DOD) and sponsored by U.S. Strategic Command and NU, NSRI strives to create a bridge from the possibilities of science and research to the realities faced by the Nation's warfighters and decision makers. Since its founding in 2012, the institute has steadily enhanced its ability to swiftly initiate research and development, ensuring readiness for action on the battlefield, during emergencies and in real-time situations.

During this reporting period, national defense priorities and strategies evolved greatly and so did the projects we tackled. In total, the institute and its partners across NU executed on 65 active projects for 33 customers. The growth of NSRI-related research activity resulted in a record-setting revenue of \$23.9 million in fiscal year 2024 and a total of \$150 million of executed research all time. To fulfill our sponsors' requirements, the institute expanded facilities and programs in several areas of research, such as joint electromagnetic spectrum operations, advanced sequencing and chemical defense.

In the summer of 2023, the institute redrew its mission, vision and core values, igniting the refinement of its goals and strategies to serve new needs while remaining true to its ultimate purpose: research and development to protect those who protect us all.

As a system-wide NU institute, NSRI is uniquely positioned to harness the intellectual and technical capacity of 16,000 faculty and staff and 50,000 students across four campuses. We channel the immense potential of a Carnegie Research 1, Big Ten Academic Alliance institution, a medical center and thriving urban and rural campuses toward defense-related problem sets, and we partner with several NU national security assets for force multiplication.



## RICK EVANS

*Maj. Gen., USAF (Ret.)*

*Executive Director*

*National Strategic Research Institute at the University of Nebraska*

This report tells a story of industry and passion that should increase confidence in the United States' ability to protect itself. In the following pages, read about 27 featured projects and their impacts for advancing preparedness, mitigation and response across the threat spectrum — chemical, biological, radiological, nuclear and explosive (CBRNE). From tailored solutions and thought leadership to improving rapid response capabilities and optimizing data and skills, NSRI demonstrated its value as a premier research institute for U.S. government agencies charged with spearheading and executing the strategic deterrence and countering weapons of mass destruction missions.

Fundamental to all of the accomplishments outlined in this report are NSRI's people: longstanding and new staff within the institute; 156 NSRI Fellows and hundreds of NU faculty just learning about the value of their UARC; long-time DOD collaborators and new USG contacts; NU and community partners. Our institute is grateful for the contributions and insights of all. In particular, we are continually energized by the participation of students, several of whom are featured in this report.

The NSRI team is proud to serve in the capacities represented by this report, and we hope readers feel called to join us as we work with our protectors to proactively deter, rapidly respond to and safely mitigate the ever-changing threats to our Nation.

Dr. Christopher Yeaw (right), NSRI associate executive director for strategic deterrence and nuclear programs, facilitates a discussion with Deborah Rosenblum, Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs, during the Nuclear Deterrence Summit, Arlington, Virginia, January 28, 2023.



## NAVIGATING GLOBAL COMPLEXITIES:

# AGILE STRATEGIES FOR A MULTI-DOMAIN WORLD

Characterized by tumultuous real-world events, a steady stream of new and evolved U.S. national security strategies and significant scientific disruptions, the timeframe of this report from July 1, 2022, through June 30, 2024, continued to demonstrate the continually advancing nature of deterrence, defense and homeland security. This period also highlighted intense challenges and intriguing opportunities spurred forward by leadership priorities around the world and progressing technologies.

With an understanding of the demands and urgencies for tailored solutions, thought leadership, rapid response and decision-making tools, the National Strategic Research Institute (NSRI) at the University of Nebraska delivered important research, development, testing, evaluation and training to partners across the U.S. Department of Defense (DOD) and U.S. Government (USG) while stretching its capacity to discover new solutions and anticipate emerging needs.

As the DOD-designated University Affiliated Research Center (UARC) of U.S. Strategic Command (USSTRATCOM) and the University of Nebraska System (NU), NSRI is required to

maintain essential research and engineering capabilities for the federal government. Its core competencies address the full threat spectrum — chemical, biological, radiological, nuclear and explosive (CBRNE) — and its research focus areas prioritize deterrence, mitigation and response.



From left: Dr. Christopher Yeaw, NSRI associate executive director; U.S. Senator Deb Fischer, Ranking Member of the Senate Armed Services Committee on Strategic Forces; Maj. Gen., USAF (Ret.) Rick Evans, NSRI executive director. At the NSRI exhibit booth during the Nuclear Deterrence Summit, Arlington, Virginia, January 28, 2023.

## Strategic Imperatives & Fascinating Disruptions

The reporting period opened with Russia entering Ukraine, leading many across the national security landscape to ask: “What would push Russian President Vladimir Putin into crossing the nuclear threshold?” While it is impossible to know, NSRI researchers have grappled with this question daily.

“We have learned through the crisis in Ukraine and our ongoing research that Putin will respect nothing short of strength. And a corollary would be that Chinese President Xi Jinping likely is in the same camp — only unambiguous strength will deter,” said Dr. Christopher Yeaw, NSRI associate executive director for strategic deterrence and nuclear programs. “The U.S. may need to rethink whether we need additional future theater nuclear capabilities to demonstrate additional strength in deterring risk-acceptant, nuclear-armed, revisionist rivals.”

These questions rest on the minds of many as the world navigates a short era containing many geopolitical structural changes. Russian submarines, potentially armed with live nuclear weapons, sailed just off the coast of Florida; China’s planned force additions are poised to put the U.S. in third place globally in terms of operationally deployed nuclear weapons; a historic mutual defense treaty between Russia and North Korea; and the Hamas-led attack on Israel and ensuing war.

“Even though 9/11 changed everything and served as a focal point for government-wide counterterrorism efforts, I think we’d have to go back to the end of

the Cold War to find a time of such truly global, multifaceted, rapid change,” Dr. Yeaw said.

Global tactical conflicts were not the only defense disruptions occurring during these two years. In contrast to the immediate, physical, violent nature of war, the world was still reflecting critically on lessons learned through the SARS-CoV-2 pandemic to prepare for potential future biological threats.

NU and NSRI continued to lead the way in several efforts related to positioning the country to successfully identify, respond to and mitigate such threats. For example, NSRI Fellows tested compounds for a prophylactic to treat acute radiation syndrome, developed prototypes for a ruggedized powered air-purifying respirator and began development of a digital twin of the human immune system. Projects such as an infectious aerosol risk study led by NSRI scientists on board U.S. Navy Ship Mercy will play a critical role in informing DOD protection of medical staff and patients from aerosolized pathogens going forward.

“The COVID-19 pandemic revealed critical gaps in our national preparedness for biological threats,” said Marty Sikes, NSRI associate executive director for chemical and biological defense programs. “NSRI and the University of Nebraska have taken these hard-learned lessons and transformed them into actionable research. Our work on the U.S. Navy Ship Mercy, for instance, demonstrates our commitment to protecting military personnel and medical staff from future airborne pathogens. By bridging the gap between civilian and military health security, we’re



**“The global strategic environment continues to evolve rapidly across a spectrum of threats. Partnerships like this one with NSRI and the University of Nebraska provide research, testing and training that is essential to U.S. strategic deterrence. It is of the utmost importance that we invest in the next generation, people from all walks of life, and capitalize on the innovation, critical thinking and modernization that they bring to the table.”**

**GENERAL ANTHONY COTTON**

*Commander, U.S. Strategic Command*





*NSRI research team sets up testing equipment for particle dispersal research on board USNS Mercy in February 2024. Conducting this research in the complex and turbulent shipboard environment while underway allowed the team to quantify risks and optimize mitigation strategies. Photo credit: ENS Lacy Burkett, assistant public affairs officer.*

forging a more resilient defense infrastructure for the challenges that lie ahead.”

It’s not far from contemplation of biological pandemic threats to a broader view of scientific development. Disruptions during this timeframe included critical scientific breakthroughs, such as the engineering physics milestone of nuclear fusion and quantum leaps in artificial intelligence (AI).

“From a national security perspective, the fusion breakthrough advances a deep understanding of the phenomena occurring in the cores of nuclear weapons, underscoring to friend and foe alike that the foundations of U.S. nuclear deterrence are second to none,” Dr. Yeaw said.

As AI technology exploded into public view, it presented national security and defense leaders with a dual-edged challenge: harnessing its immense potential to enhance capabilities while simultaneously guarding against its misuse by adversaries. This necessitates continuous adaptation of strategies, policies and ethical frameworks to ensure responsible development and deployment, all while staying ahead in an increasingly AI-driven global security landscape.

“Emerging technologies have changed the threat landscape and make engineered threats more feasible,” said Dr. Neal Woollen, NSRI associate executive director for countering weapons of mass destruction allied programs. “We need a new generation of solutions that are more flexible and agile to be ready for the unexpected.”

The convergence of geopolitical shifts, evolving threats and emerging technologies demands a proactive approach to strategy formulation and execution. NSRI is assisting with this aspect of defense, as well, through projects that further strategic analysis and planning, helping commanders find ways to harness innovation and achieve new levels of adaptability for resilient future forces.

## New Leadership & Evolving Strategies

U.S. Air Force General Anthony Cotton relieved U.S. Navy Admiral Charles Richard as commander of USSTRATCOM during a ceremony at Offutt Air Force Base on December 9, 2022. As USSTRATCOM’s UARC, NSRI wasted no time identifying how it could support the new commander’s vision — from strategic deterrence research to joint electromagnetic spectrum operational tools to leveraging advanced database technology for operational practice and planning and more.

Several strategies and reports related to USSTRATCOM’s mission space were published in this time frame, including the 2023 Strategic Posture Commission Report. Produced by a bipartisan Congressional Commission, the report emphasized an urgent need for an upgrade of nuclear capabilities: “The vision of a world without nuclear weapons, aspirational even in 2009, is more improbable now than ever.”

The report underscored the importance of NSRI’s wargaming efforts with the U.S. Department of Energy National Nuclear Security Administration (NNSA). Leveraging a \$25 million indefinite delivery, indefinite quantity contract established by NNSA in 2021, NSRI executed four wargames with NNSA leaders to help increase their resilience and adaptability for the nuclear weapons complex. As declared in the commission’s report, augmentations to the theater nuclear force are imminent and NSRI

is helping the NNSA and the broader defense community think through the strategies, impacts and consequences.

Several national strategies influenced NSRI's chemical and biological defense efforts, particularly the 2022 National Defense Strategy, the 2022 National Biodefense Strategy and Implementation Plan and the 2023 Biodefense Posture Review. Key takeaways include but are not limited to: emphasis on early warning and understanding of biological threats, the pivot to agnostic threat detection, increased focus on biosafety and biosecurity and renewed investments in biosurveillance.

In November 2022 U.S. President Joe Biden published National Security Memorandum 16 (NSM-16) on Strengthening the Security and Resilience of U.S. Food and Agriculture. NSM-16 punctuated the importance of NSRI's new food, agriculture and environment security focus area, developed in partnership with the University of Nebraska–Lincoln Institute of Agriculture and Natural Resources.

The intent of the focus area is to help America's leaders determine how to best protect the Nation's food supply chains, agricultural systems and the environment from attack, adulteration and disease. Several strategic planning events within NU and with government partners including the U.S. Department

## NATIONAL STRATEGIES

Prompted by changes in administration and leadership as well as learnings from the COVID-19 pandemic, numerous defense-related institutions published strategies in this period. The following publications significantly influenced the analysis and development of NSRI's mission and capabilities.

- ▶ 2022 National Defense Strategy, including the 2022 Nuclear Posture Review and 2022 Missile Defense Review
- ▶ 2023 Strategic Posture Commission Report
- ▶ 2022 National Biodefense Strategy and Implementation Plan
- ▶ 2023 Biodefense Posture Review
- ▶ 2023 Strategy for Countering Weapons of Mass Destruction
- ▶ National Security Memorandum on Strengthening the Security and Resilience of United States Food and Agriculture
- ▶ 2023 National Defense Science and Technology Strategy

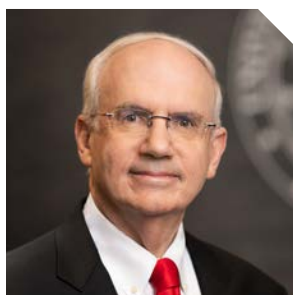
*Dr. Neal Woollen, NSRI associate executive director, speaks at the podium during an NSRI-hosted faculty workshop at the East Campus Union at the University of Nebraska–Lincoln, Lincoln, Nebraska. The workshop launched the new NSRI focus area — food, agriculture and environment security. March 8, 2023.*







*Recognition of U.S. Strategic Command on the field at the Nebraska Cornhuskers Military Appreciation football game, Memorial Stadium, Lincoln, Nebraska, November 11, 2023. From left: Maj. Gen., USAF (Ret.) Rick Evans, NSRI Executive Director; Trev Alberts, Nebraska Athletics Director; Sergeant Major Howard Kremer, USSTRATCOM Command Senior Enlisted Leader; General Anthony Cotton, USSTRATCOM Commander; VADM (Ret.) Ted Carter, former (eighth) NU President.*



**“On behalf of the University of Nebraska, we want to thank our neighbors and partners at U.S. Strategic Command for their ongoing support of NSRI. Nebraska has a long history of leadership in helping to keep our Nation safe, and the University is proud to play a role in that work. I congratulate the many faculty, staff and students whose expertise has contributed to NSRI’s mission, and I am excited about the collaborative work ahead. Thank you, as always, to the women and men whose service and sacrifice protect our freedom in Nebraska and around the world.”**

**DR. JEFFREY GOLD**

*Ninth and current President, University of Nebraska System*

of Agriculture, U.S. Department of Homeland Security and the U.S. Federal Bureau of Investigation have identified priorities for this area, many of which were guided in part by NSM-16.

The array of national strategies the institute examined provided invaluable insights, shaping NSRI’s approach to complex global challenges. By synthesizing these lessons, NSRI enhanced its capabilities and positioned itself to offer more comprehensive and nuanced solutions to its partners in government and academia.

## **Respond, Advance, Deliver**

Boasting more than 525 years of combined service and ongoing support to national security missions, the NSRI leadership team employs a deep understanding of and rich expertise for CBRNE deterrence, mitigation and response. Passionate, talented scientific staff of the institute collaborate across DOD and USG agencies and create opportunities for those agencies to engage with NU researchers to bring forward resources, capacity and capabilities the Nation needs to execute strategies and prepare for future threats.

The facilities, technologies and 27 projects featured throughout this report demonstrate NSRI’s and NU’s ongoing commitment to USSTRATCOM and its mission partners.



# IMPACT METRICS

NSRI's research and development efforts are designed to put solutions into the hands of DOD end users: decision makers and warfighters. The institute's work spans multiple mission areas, disciplines, teams, agencies and institutions. This page presents key metrics that quantify the reach and influence of NSRI in this reporting period and since it was established in 2012.

▶▶▶ View mission milestones since 2012 at [nsri.nebraska.edu/milestones](https://nsri.nebraska.edu/milestones).

## ALL TIME



**188** CONTRACTS  
AWARDED



**53** SPONSORING  
AGENCIES



**\$293 MILLION**

TOTAL AWARD VALUE FOR  
RESEARCH CONTRACTS



**\$150 MILLION**

TOTAL EXECUTED RESEARCH  
VALUE

## JULY 1, 2022 – JUNE 30, 2024



**65** ACTIVE  
PROJECTS



**40** NU RESEARCHERS  
lead or contribute to projects



**22** NU STUDENTS  
contribute to projects



**\$770,342**

TOTAL PAID TO STUDENT  
RESEARCHERS



“The NSRI Board of Directors is proud of the NSRI team and its accomplishments since its founding. With the University of Nebraska, NSRI continues accomplishing vital research that has met key priorities for U.S. Strategic Command and many other agencies across the U.S. Department of Defense and the federal government. The engagement of NSRI leaders and university investigators has led to unique solutions to strategic challenges of today and the future.”

**CARL MAUNEY**

*Vice Admiral, USN (Ret.), Chairman, NSRI Board of Directors*

# RESEARCH FOR MISSION IMPACT

This reporting period, like those immediately prior and surely those to come, was marked by an increasingly turbulent national security landscape. As a University Affiliated Research Center (UARC), designated by the U.S. Department of Defense (DOD) and sponsored by U.S. Strategic Command (USSTRATCOM), the National Strategic Research Institute (NSRI) at the University of Nebraska (NU) remains a responsive partner and trusted problem solver for sponsors across the U.S. Government (USG). In addition to its team of leading subject matter experts, the institute harnesses science, engineering, medical and policy capabilities of hundreds of researchers and students who work in state-of-the-art facilities across NU's four campuses.

NSRI's research teams worked closely with sponsors through 65 active projects to tackle emerging challenges, leveraging research to identify new threats, applying new concepts and technology to mitigate risks and pioneering new capabilities to serve as a force multiplier for the Nation's defense and intelligence communities.

The following pages feature NSRI's five research focus areas, a summary of some of the work completed within the last two years and a list of enduring capabilities. Featured projects and deliverables are organized within four key themes, demonstrating NSRI's commitment to providing the DOD and USG:

- ▶ Foresight for tailored solutions
- ▶ Thought leadership for actionable outcomes
- ▶ Rapid-response to real-time challenges
- ▶ Optimized data and skills for efficient decision making

*Bomb technician participant tests a protective suit during an NSRI homemade explosives training course with the U.S. National Guard 6th Civil Support Team, April 2024, Albuquerque, New Mexico.*



# Research Portfolio

To accomplish its mission, NSRI's research portfolio is comprised of five focus areas derived from its UARC core competencies.

## UARC Core Competencies

- ▶ Active & Passive Defense Against Weapons of Mass Destruction
- ▶ Nuclear Detection & Forensics
- ▶ Consequence Management
- ▶ Detection of Chemical & Biological Weapons
- ▶ Mission-Related Research

## Focus Areas

- ▶ Strategic Deterrence & Nuclear Programs
- ▶ Chemical & Biological Threat Detection & Countermeasure Development
- ▶ Threat-Based Training & Exercise Support
- ▶ Medical Countermeasures
- ▶ Food, Agriculture & Environment Security

In its role as USSTRATCOM's UARC, NSRI is uniquely equipped to think through the entire range of strategic attack scenarios — nuclear and non-nuclear, kinetic and non-kinetic — masterfully channeling and connecting capabilities of the five focus areas into elegant solutions that help the DOD and the Nation successfully execute toward the mission of deterring strategic attack.

The institute purposefully bridges research in the USSTRATCOM mission space and the countering weapons of mass destruction (CWMD) mission space — finding and filling gaps, assessing and asserting links, exploring and solving problems.

# Focus Area Highlights

During this reporting period, NSRI addressed specific defense-related needs and solutions that sometimes remain within the boundaries of one focus area and sometimes overlap into other areas. This section of the report both summarizes recent developments by area and describes capabilities that USSTRATCOM, the DOD and other defense agencies may put into play in the coming years.

## Strategic Deterrence & Nuclear Programs

NSRI played an important role throughout the two-year reporting period, leading high-level efforts to understand the dynamic strategic and nuclear global landscape. With revolutionary changes in the Chinese nuclear force and repeated threats of nuclear escalation in the Russo-Ukrainian conflict, the tripolar nuclear rivalry that the U.S. finds itself within calls for rebalancing in its nuclear posture.

NSRI actively assists government and defense leaders in exploring the range of possible future deterrence requirements and the art of the possible to meet those requirements. In this period, NSRI developed and delivered extensive strategic escalation wargames and warhead design workshops for the National Nuclear Security Administration (NNSA) that will continue into 2025.

In July 2023, USSTRATCOM stood up the Joint Electromagnetic Spectrum (EMS) Operations Center (JEC). With several EMS subject matter experts on staff, NSRI was ready to investigate technical issues for EMS dominance. In January 2024, the institute launched research and development of innovative enabling technologies and support for coordinated adaptations to tactics, techniques and procedures in EMS operations. The institute delivered the initial results of this work and is seeking to expand its footprint in this vital mission by collaborating across the DOD.

Looking ahead, NSRI is supporting a Defense Threat Reduction Agency initiative to deliberate on the fundamental assurance requirements of Allies and extended deterrence. NSRI personnel will lead thought leaders and policy experts from

Australia, Japan and South Korea through a strategic escalation wargame and workshop in early 2025. They will capture, analyze and synthesize these Allied perspectives regarding what is needed to assure them and to extend deterrence to U.S. Indo-Pacific Allies and partners.

In anticipation of future needs, NSRI is pursuing research and analysis for countering Russian and Chinese military concepts that include homeland nuclear strikes against the U.S.; conceiving and prototyping innovative nuclear sensors deployable nationwide; and considering various theater nuclear systems and operational concepts for the future U.S. nuclear deterrent.

## CAPABILITIES

- ▶ Weapons policy analysis: foreign threats, arms control, conceptual weapon design, strategic materials production
- ▶ Strategic conflict deterrence and escalation dynamics: tabletop exercises, wargames, model development, decision support tools
- ▶ Consequence management: nuclear detection and forensics, hazard modeling, disaster mitigation research
- ▶ Support technologies: future nuclear command, control and communications technology exploration, advanced concepts and architecture, materials research, advanced manufacturing, nuclear certification



Dr. Christopher Yeaw (far right on stage), NSRI associate executive director, introduces a discussion panel entitled “Strategies for deterring two nuclear-armed peer competitors” at the USSTRATCOM Deterrence Symposium in July 2022, Omaha, Nebraska. U.S. Air Force photo by TSgt. Taylor Drzazgowski.



Marty Sikes (far right on stage), NSRI associate executive director, moderates the panel, “Utilizing Emerging Tech to Aid Response & Recovery in a CBRN Affected Dense Urban Environment,” at the March 2024 Joint Civil & DOD CBRN Symposium, Washington, D.C.

## Chemical & Biological Threat Detection & Countermeasure Development

The past two years saw notable advances in biotechnology and other disruptive technologies that are expanding the scope of biothreats across the globe, including Russian and Chinese activities that U.S. national security leaders are watching closely. To help government customers address the myriad challenges, the NSRI chemical and biological defense team focused on research, development, testing and evaluation (RDT&E) of next-generation chemical and biological threat sensors and decontamination systems; rapid prototyping of novel collection; exploitation and detection systems on robotic platforms; and assessment and analysis of emerging threats, risks, capabilities and vulnerabilities.

The team significantly expanded NSRI’s advanced sequencing capabilities, capacity and access to NU campuses. Among many achievements, the institute was awarded a new \$16 million indefinite delivery, indefinite quantity contract. Additionally, the team expanded the NSRI Space Coast Field Office located in Melbourne, Florida, to include an advanced sequencing and sample exploitation laboratory. All of this positions NSRI as a responsive support to government sponsors as they pivot to address emerging man-made and naturally occurring threats.

Significant growth in chemical defense projects inspired a 15,000-square-foot expansion of the NSRI Conference Center and Laboratory in Annapolis



Junction, Maryland. The team delivered advanced sensing systems to accomplish hard target surveillance and reconnaissance and unmanned system-based CWMD capabilities with associated enabling technologies. A newly developed hazardous chemical extraction system was created to safely extract, transport and store hazardous chemicals from field munitions and storage containers.

Looking forward, NSRI seeks to expand RDT&E efforts by enhancing sequencing capabilities, leaning into its experience and expertise in early warning and networking sensors, including robotic platforms, and incorporating broader applications of artificial intelligence (AI), machine learning, modeling and bioinformatics.

## CAPABILITIES

- ▶ Development of detection, collection, identification and exploitation strategies and technologies
- ▶ Hazard detection, decontamination, mitigation and remediation
- ▶ Aerosol science: environmental characterization and dissemination
- ▶ Materials biology: substrate effects, binding kinetics and surface integration
- ▶ Threat and effects: intelligence analysis, modeling and simulation studies
- ▶ Technical collection, field exploitation and forensics
- ▶ Rapid prototyping and development
- ▶ Testing and evaluation / independent verification and validation

## Threat-Based Training & Exercise Support

Within an evolving landscape of weapons of mass destruction, terrorist threats, illicit drug manufacturing and infectious diseases, local, state and federal response teams bear significant responsibility to safeguard citizens nationwide, alongside law enforcement, HAZMAT teams and medical personnel.

Over the past two years, NSRI supported the responder community by successfully designing and delivering 15 specialized courses, reaching

approximately 750 participants. Each course was meticulously structured to provide a blend of theoretical knowledge and practical, hands-on experience, helping ensure participants could apply what they learned directly in the field.

Recognizing the increasing complexity and sophistication of biological threats, NSRI focused on integrating state-of-the-art detection tools and analytical methods into the training curriculum. This included using portable real-time polymerase chain reaction devices, biosensors and other innovative diagnostic technologies that have become critical in identifying and responding to threats quickly and accurately. Participants reported a significant boost in their ability to effectively detect and assess biological threats using the latest technologies, thereby enhancing public safety.

To remain on the forefront, NSRI courses will continue to incorporate interdisciplinary collaboration that increases efficiency in real-world response and integrate technology, such as AI, to personalize training experiences. With ongoing challenges posed by climate change and global instability, NSRI expects to support an increased focus on preparing for natural disasters that involve hazardous materials. It will develop new training modules to address the intersection



Members of the NSRI field operations and training team following successful delivery of mobility and delivery training evolution for the U.S. National Guard 43rd Civil Support Team, August 2022, Charleston, South Carolina. From left: Daniel Polanski, Paul Brantmier, Marty Sikes III.

of environmental hazards and chemical, biological, radiological, nuclear and explosive (CBRNE) threats.

## CAPABILITIES

- ▶ Academic, hands-on, just-in-time and scenario-driven programs across the CBRNE threat spectrum, conducted on site or at NSRI's secure location
- ▶ Full-scale exercise coordination challenging all levels of technical and tactical weapons of mass destruction (WMD) response teams
- ▶ Sponsor-tailored scenarios that promote multi-jurisdiction participation of mission partners during WMD-related incidents
- ▶ Advanced development and facilitation of acquisition support and DOD testing and evaluation activities
- ▶ Subject matter expert support for customer-run exercises

## Medical Countermeasures

During this reporting period, the medical community remained focused on the devastating effects of the COVID pandemic, carrying forward lessons learned to help prevent and improve response to future chemical, biological or radiological incidents. At the same time, the evolving threat environment is being fueled by rapid technological advances in areas such

as genetic engineering and AI. The need to respond quickly with deployable medical solutions is more critical than at any time in the history of the Nation.

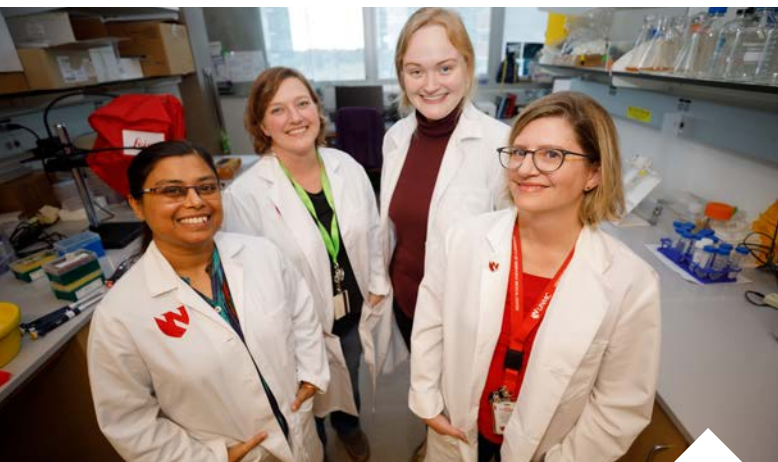
Led by a new director for medical countermeasures hired in this reporting period, NSRI is advancing response through several projects and capabilities. In 2023, NSRI received a \$24.5 million contract to continue the development of a prophylactic for acute radiation syndrome. Partnering with industry and academic research and development, an NSRI team is exploring a burn ointment that works well on thermal burns in the civilian sector and could treat both radiation dermatitis and radiation burns for warfighters. Similarly, therapeutic delivery devices built for delivering insulin to diabetic patients could deliver battlefield therapeutics and prophylactics and, in some cases, even replace IVs, reducing incident response time from minutes to seconds.

National reports, such as the Apollo Report published by the Bipartisan Commission on Biodefense in January 2021, shed light on important challenges and potential solutions for the military medical community and guide NSRI's development for future research priorities. NSRI and NU are actively engaged in development efforts to address multiple priorities highlighted in the report, including point-of-need diagnostics, wearable sensors, drug delivery devices and AI-aided development of vaccine candidates.

Looking forward, NSRI's medical countermeasures focus area will continue to leverage NU core laboratories for drugs, devices and modeling and simulation tools and seek connections with industry to achieve technology transition of potential solutions and modify existing DOD-specific applications.

## CAPABILITIES

- ▶ Multisystem disaster medicine readiness and response solutions for CBRNE threats
- ▶ High-consequence, pathogen-infected patient management and training
- ▶ Vaccine, therapeutic, diagnostic capability discovery and development



NSRI Fellow Dr. Rebecca Oberley-Deegan (right) and her laboratory colleagues contribute their expertise in identifying radioprotectors for a Defense Health Agency project through NSRI. From left: Arpita Chatterjee, Annie Kosmacek, Molly Myers.



NSRI Fellow Dr. George Grispos, assistant professor in the school of interdisciplinary informatics at the University of Nebraska at Omaha, presents at a food, agriculture and environment security faculty workshop hosted by NSRI at the University of Nebraska–Lincoln East Campus Union, Lincoln, Nebraska, March 2023.



## Food, Agriculture & Environment Security

In early 2022, NSRI and the Institute of Agriculture and Natural Resources (IANR) at the University of Nebraska–Lincoln set out to realize their potential and fulfill their responsibility to contribute to U.S. food, agriculture and environment security. IANR's long history of innovation and partnership with industry and producers, combined with NSRI's UARC status and deep experience and expertise with CBRN threats, creates a unique opportunity to not only participate in conversations about some of the Nation's most critical infrastructure but to lead needed research and development of solutions.

NSRI's and IANR's foresight was underscored by National Security Memorandum 16 on Strengthening the Security and Resilience of United States Food and Agriculture, signed in November 2022. Real-world events such as an outbreak of highly pathogenic avian influenza (HPAI) affecting dairy cattle further emphasized the need for this focus area of research under the NSRI portfolio of work.

The partners joined conversations with federal government agencies such as the U.S. Federal Bureau of Investigation and the U.S. Department of Agriculture. They convened 60 NU researchers through a launch workshop, and 32 NSRI Fellows

formed a working group, which led a discussion at the 2024 NSRI Fellows Conference.

NSRI, IANR and additional NU partners aim to help the Nation's food and agriculture sector become more resilient to future threats through a whole-of-society approach that addresses direct and indirect effects of security-related incidents. Addressing the indirect effects, such as geopolitical and socioeconomic impacts, may also help stakeholders identify and provide resiliency solutions beyond threats to the food and agriculture sector.

### CAPABILITIES

- ▶ Animal agriculture, plant, crop and environmental threat mitigation, including foreign, transboundary and high-consequence pathogens
- ▶ Food safety and security
- ▶ Entomology
- ▶ Agricultural terrorism
- ▶ Cyber threats to precision agriculture systems
- ▶ Environmental, agricultural and occupational health, with a focus on One-Health perspectives
- ▶ Systems thinking and systems dynamics



*From left: Dr. David Berkowitz, Willa Cather professor of chemistry at the University of Nebraska–Lincoln (UNL); Maj. Gen., USAF (Ret.) Rick Evans, NSRI executive director; Dr. Ken Bayles, vice chancellor for research at the University of Nebraska Medical Center. Each represent a team involved in supporting ongoing research for the Defense Health Agency. They are shown in front of UNL's new 15-Tesla ICR-MS instrument on campus in Hamilton Hall, Lincoln, Nebraska.*

## COUNTERING NASCENT THREATS:

# FORESIGHT FOR TAILORED SOLUTIONS

In a world where adversaries enthusiastically develop technologically advanced devices and strategies, it is critical for the defense enterprise to proactively formulate solutions now to mitigate future attacks. Researchers embedded in the National Strategic Research Institute (NSRI) and the University of Nebraska System's (NU) four campuses continue to elevate capabilities toward new agile solutions — and new uses for existing solutions. During this period, projects launched through NSRI fit this need and delivered promising products to end users.

### Developing Small Molecule Prophylactic Treatments to Protect U.S. Troops from Radiation

Acute radiation syndrome (ARS) poses a grave threat to the Nation's warfighters and first responders. It is induced by exposure to elevated levels of ionizing radiation, which can come from a dirty bomb attack, nuclear accident or nuclear detonation. Russia's potential employment of tactical nuclear armaments during its invasion of Ukraine throughout this reporting period made the threat of nuclear weapons use and the need for medical countermeasures to prevent and mitigate ARS more real than it has been at any point in recent decades.

To bolster readiness, NSRI leveraged researchers from the University of Nebraska–Lincoln (UNL), the University of Nebraska Medical Center (UNMC) and the Armed Forces Radiobiology Research Institute

to advance development of a prophylactic treatment designed to safeguard U.S. troops.

The Defense Health Agency (DHA) awarded NSRI a \$24.5 million contract in September 2023 to propel this research into the next phase — the highest single-project award in NSRI's history. The award was the third such contract from DHA for this endeavor, totaling more than \$35 million in funding since 2017. The research team achieved substantial progress in the initial pharmacokinetic and pharmacodynamic testing on multiple candidate compounds and is currently evaluating candidates and amassing data for evaluation and approval by the Food and Drug Administration.

In the hands of military warfighters and civilian first responders, NU's preventative ARS treatment can help ensure a resilient force for an unthinkable nuclear event in the homeland.

## Innovation Creates Faster, Safer Medical Equipment Sterilization

When treating injured soldiers or mass-casualty victims, obtaining sterile equipment to reduce infection is difficult since sterilization has required a specific supply of power and water, bulky equipment and long cycle times. In early 2022, NSRI began contributing to a multi-year effort to develop power-free field equipment sterilization. With the Naval Surface Warfare Center Indian Head Division and Johns Hopkins Applied Physics Lab, NSRI scientists conducted bioefficacy testing of hot biocidal vapors to sterilize surgical tools. The technique was repurposed from a project using rapid defeat energetic formulations for countering weapons of mass destruction.

Five-minute tests successfully demonstrated baseline reduction in *Staphylococcus aureus* vegetative cells and *Bacillus thuringiensis* spores — without hazardous chemical vapors and with a short cool down cycle. The team aims to optimize the process and produce a functional mobile sterilization tool to save lives in the field.

## Testing Medical Countermeasures for Emerging Chemical Threats

In 2012, Russian special forces employed a non-traditional, fentanyl-based chemical agent to stop terrorists who had taken hostages, but it also took the lives of civilians. The use of this agent demonstrated a new emerging threat to DOD forces.

An NU team is exploring medical countermeasures to keep U.S. Forces safe from such agents. The research falls under a \$6.5 million award from the U.S. Defense Threat Reduction Agency (DTRA).

Milestones achieved so far include safety and efficacy testing of multiple medical countermeasures targeting opioid and non-opioid pharmaceutical-based agents; optimizing dosing based on agent exposure levels; determining potential cardiovascular and respiratory effects; and cognition and anxiety testing to ensure the countermeasures do not impair the warfighter's ability to fight.

The Nation needs resources, personnel, strategies and experience in place to quickly and decisively respond to future threats. DTRA is investing up front, and NU and NSRI scientists are executing these needs before events take place.

## Underway Infectious Aerosol Risk Study Contributes to Key Insights

During the COVID-19 pandemic, the U.S. Navy's two hospital ships deployed to Los Angeles and New York City to provide citizen care. The experience on board prompted DTRA to fund further evaluation of particle dispersal in the ships' medical spaces.

Underway on the United States Naval Ship Mercy for nine days in February 2024, an NSRI research team conducted 59 tests using fluorescent tracer particles with unique signatures not naturally present, a custom aerosol generator and a particle sensor network for continuous environmental monitoring.

Study conclusions will play a critical role in the U.S. Navy's and Military Sealift Command's protection of medical staff and patients from aerosolized pathogens on fleet hospital ships.



NSRI research team sets up testing equipment for particle dispersal research on board USNS Mercy in February 2024. Conducting this research in the complex and turbulent shipboard environment while underway allowed the team to quantify risks and optimize mitigation strategies. Photo credit: ENS Lacy Burkett, assistant public affairs officer.

## Strategic Deterrence Experts Stretch Knowledge for Policy

At a 2023 committee session of the National Academies for Sciences, Engineering and Medicine, Dr. Christopher Yeaw, NSRI associate executive director, presented forward-looking insight into U.S. nuclear strategy and policy as part of a study of potential environmental effects of a nuclear weapons exchange.

At the 2023 Nuclear Deterrence Summit in Washington, D.C., Dr. Yeaw moderated for Deborah Rosenblum, DOD Assistant Secretary of Defense



for Nuclear, Chemical, and Biological Defense Programs, and he presented on a panel regarding U.S. readiness. Dr. Yeaw followed up on the concept of readiness with remarks at the 2024 Nuclear Deterrence Summit, making it clear that the balance of nonstrategic nuclear weapons weighs very negatively against the U.S. and warrants immediate attention.

At the 2023 Project on Nuclear Issues Conference, NSRI intern Grace Farson presented first-of-its-kind research applying mathematical game theory to a potential tripolar nuclear conflict.

Presentations by NSRI leaders and student interns introduce cutting-edge research in U.S. Strategic Command's mission area, adding to a national discussion that can evolve U.S. deterrence strategies and policies.

## Unique Service Model Advances CBRNE First Responder Skills

NSRI supports first responders through training resources and expertise for all federal government agencies with missions related to chemical, biological, radiological, nuclear and explosive (CBRNE) threats. In late 2022, NSRI launched new all-hazards training through a \$1.5 million contract sponsored by the U.S. National Guard 24th Civil Support Team.

NSRI's unique service model prepares responders for hazard events ranging from advanced medical treatment for HAZMAT to chemical and biological sampling and decontamination. The team also helps identify and evaluate emerging technologies.

## Determining Future Colorimetric Indicator Requirements

Colorimetric indicators have been a functional asset allowing military teams to respond to indicated battlefield threats; however, they have not evolved significantly for decades. In the summer of 2023, NSRI scientists helped advance this technology by hosting a workshop with program managers from DTRA and the Joint Program Executive Office (JPEO), as well as end users from the joint services. Attendees outlined the state of the technology and documented requests for new indicator technologies.

With results of the workshop in hand, NSRI conducted a market survey to catalog existing solutions. For requirements without solutions, NSRI outlined goals for future DOD-funded research and development efforts. The final report was delivered in December 2023.

With existing solutions and research requirements identified, DTRA and JPEO have an actionable strategic plan for advancing colorimetric indicator technologies.

## NSRI, NU Launch Initiative to Build Resilience for Food, Agriculture & Environment Defense


U.S. President Joe Biden's National Security Memorandum 16 (NSM-16) on Strengthening the Security and Resilience of United States Food and Agriculture focuses specifically on CBRN threats to the food and agriculture sector. In response to NSM-16, NSRI co-hosted a workshop with the University of Nebraska–Lincoln Institute of Agriculture and Natural Resources in March 2023 to launch a critical new NSRI focus area: food, agriculture and environment security.

More than 60 researchers convened to leverage the university's 150 years of food industry research prowess in support of the DOD, U.S. Department of Homeland Security, U.S. Department of Agriculture, Food and Drug Administration and other agencies working in this space.

Early strategic planning sessions in 2023 targeted three key threats: climate change, bad actors and the need for interdisciplinary integration to build toward a coordinated national defense of food, environment and agriculture. Download proceedings at [nsri.nebraska.edu/faes](https://nsri.nebraska.edu/faes).



Dr. Andreia Bianchini Huebner, associate professor in the UNL food science and technology department, discussed how to safeguard the food supply chain at a faculty workshop hosted by NSRI at UNL East Campus, Lincoln, Nebraska, March 8, 2023.



Thomas DiNanno (left), NSRI director for strategic resiliency and wargaming, and Dr. Christopher Yeaw (right), NSRI associate executive director, lead attendees through a three-hour wargame scenario at the Black Hills Defense & Industry Symposium, April 10, 2024, Box Elder, South Dakota. The scenario was based on a near-peer, nuclear-capable INDO-PACOM threat, providing a clear realization of how vulnerable the U.S. may be if and when it has to confront an adversary that can capably execute nuclear escalation.

## CONTRIBUTING TO REAL-WORLD STRATEGIES:

# THOUGHT LEADERSHIP FOR ACTIONABLE OUTCOMES

In this reporting period, the National Strategic Research Institute (NSRI) and the University of Nebraska System (NU) collaborated with partners from the U.S. Department of Defense (DOD) and the U.S. Government to convene broad expertise and knowledge for a deeper understanding of impending key national security challenges and potential solutions. Engaging in and facilitating interdisciplinary, interagency teams allowed NSRI to hone in on priorities, determine forward actions and integrate resources across its mission space.

## Support to NNSA for Strategic Deterrence & Nuclear Threat Reduction

The National Nuclear Security Administration (NNSA), a semi-autonomous agency within the U.S. Department of Energy, maintains and enhances the safety, security and reliability of the U.S. nuclear weapons stockpile while working to reduce global danger from weapons of mass destruction.

A principal partner of U.S. Strategic Command, (USSTRATCOM), NNSA sought out the command's DOD-designated University Affiliated Research Center, NSRI, awarding a \$25 million indefinite delivery, indefinite quantity contract in 2021. Within

this reporting period, NSRI delivered an elucidating analytical effort to the customer on historic approaches to warhead design among the U.S., Russia and China and executed an initial round of strategic escalation wargames for NNSA leaders at the agency's headquarters.

NSRI's warhead design study and limited nuclear conflict wargame provide strategic support to mission-oriented educational objectives and future NNSA strategic decisions regarding nuclear weapons policy and acquisition, important particularly as the U.S. faces an emerging requirement to build out a suitable theater nuclear force. These efforts will continue as NSRI upgrades the wargame software and prepares to execute several wargames in 2024 and 2025.

## Medical Countermeasures Capabilities Featured at MHSRS

NU and NSRI scientists participated in multiple conferences and symposia across several disciplines for drug discovery and development. In particular, the Military Health System Research Symposium (MHSRS) provides an opportunity to engage government, academia and industry. The DOD's foremost scientific meeting, MHSRS focuses on the unique medical needs of the warfighter, drawing nearly 4,000 attendees and providing a venue for sharing new scientific knowledge from military-unique research and development.

NSRI and NU presented and exhibited at the event in 2023. Presentations included but were not limited to: Isolation System for Treatment and Agile Response for High-Risk Infections (ISTARI): New Concepts for Continuous Patient Isolation and Care; REMIS: Rapid Energetic Medical Instrument Sterilization; and Advancement in Forward Surgical Care in Times of Need.

Through this highly collaborative annual event, NSRI and NU exchange research and healthcare initiatives with hundreds of industry-leading military providers with deployment experience, research and academic scientists, international partners and industry. In total, more than 100 direct contacts were collected, with several engaging in collaborations.

## NSRI & MIT Partner for Student Research Program to Detect Biological Threats

NSRI launched a strategic partnership with Lincoln Laboratory, the Federally Funded Research and Development Center of the Massachusetts Institute of Technology (MIT), to create a student research program that aims to develop innovative solutions to detect and neutralize emerging biological threats. Funded by a DOD agency, the multi-year program addresses basic research. It is currently focused on agriculture security and global health issues.

Twelve MIT mechanical engineering students produced and validated a gas gradient manifold prototype and a droplet-dispensing manifold that has the potential to generate arbitrary pH gradients in industry-standard 96-well plates used for biomedical research. These devices will greatly simplify and accelerate the microculture of complex mixtures of organisms, allowing the end user to dial in the optimal environmental parameters without the need for expensive, bulky hardware.

## Full-Scale Exercise Prepares Indiana First Responders for Worst-Case Scenarios

Before the February 2024 NBA All-Star game in Indianapolis, Indiana, NSRI's field operations and training team facilitated a full-scale, multi-device biological and explosive threat response exercise for the U.S. National Guard 53rd Civil Support Team (CST) and response partners.

The simulation leveraged NSRI's subject matter knowledge and experience to coordinate multiple agencies, evaluate individual and team responses and provide insight to prepare responders for major real-life events. Participants included a bomb squad, K-9 unit and Pacers team staff and security. The FBI provided command and control. The team simulated the intensity and chaos of a real multi-device threat to effectively develop participants' skills, hone field analysis capabilities and evaluate protocols, devices and interagency communications.

NSRI full-scale threat response exercises provide unique scenarios where interagency teams can fine-tune operations and continue improving tactical responses to national security level events.



*U.S. National Guard 53<sup>rd</sup> Civil Support Team members prepare to go down range to investigate device during an NSRI full-scale exercise, Indianapolis, Indiana, January 2024.*



## Biodefense Insights Inform National Defense Community

The DOD invited NSRI scientists focused on biological defense to present their perspectives across threat detection, countermeasure development and environment surveillance at several events and forums.

Panel presentations and a poster at the Chemical & Biological Defense Science & Technology Conference, December 2022, in San Francisco, California, showcased NSRI work for the Defense Threat Reduction Agency, including rapidly dissolvable filters for biological aerosol sample collection and a remote sensing system to detect biological threats.

The U.S. Department of Homeland Security requested NSRI scientists to virtually moderate and participate in panel discussions surrounding hazard-related testing for the Built Environment Surveillance Testbed–Biological Hazards Summit in June 2023.

At the Joint Civil & DOD CBRN Symposium, March 2024, in Washington, D.C., NSRI Associate Executive Director Marty Sikes moderated a panel highlighting challenges and strengthening preparedness for CBRN threats. The panel explored employing artificial intelligence (AI), machine learning (ML), unmanned platforms and microsensors, which have been a top priority to modernize and enhance CBRN detection and response capabilities.

With colleagues throughout the U.S. and across rapidly evolving defense disciplines, NSRI scientists are contributing greater national capacity to investigate vulnerabilities, identify threats and mitigate current and future risks.

## Examination of Advanced Adversarial Technology to Evolve Deterrence

As new chemical and biological technologies change the threat landscape, near-peer adversaries' escalation tactics and related considerations must be studied to define evolved deterrence methodologies and weapons employment doctrine.

The Deputy Assistant Secretary of Defense for Chemical and Biological Defense asked NSRI to host and facilitate a series of workshops in June of 2023 to examine changes in the threat landscape and explore methods of addressing them.

Throughout the series of "Future Operating Environment" workshops, DOD, USSTRATCOM and NU leaders and researchers scrutinized strategic perspectives on synthetic biology, AI, ML and more.

The highly collaborative workshop discussions among technicians and thought leaders from academia, the military and government provided an investigation of key drivers and inhibitors of near-peer chemical and biological weapons employment, including assessing historical and contemporary views.

## Dispersing Threats Knowledge to Increase Agriculture Security

The U.S. Federal Bureau of Investigation's Omaha Field Office and the Nebraska Farm Bureau hosted an Agriculture Threats Symposium at Nebraska Innovation Campus in Lincoln, Nebraska, in June 2023, to provide information to farmers and ranchers about threats to the agriculture sector in the Upper Midwest and to offer resources and guidance to prevent, detect and mitigate these threats.

Dr. Neal Woollen, NSRI associate executive director, and NSRI Fellow Dr. Benny Mote, UNL associate professor of animal science, presented a talk entitled, "Resiliency Challenges with High Consequence Pathogen Outbreaks."

The event started a critical conversation among the private sector, government, law enforcement and academia about how to protect agriculture from threats.



NSRI Fellow Benny Mote, associate professor and swine extension specialist at the University of Nebraska–Lincoln, presenting at the FBI Agriculture Threats Symposium, Lincoln, Nebraska, June 2023.

*An electric vehicle ruptures a roadside guardrail and impacts a containment structure during a test on October 2023 at the Midwest Roadside Safety Facility at the University of Nebraska–Lincoln, Lincoln, Nebraska. Changes in the vehicle fleet, including design, powertrain, inertial properties and weight, require periodic updates to the design of roadside hardware and protective structures, including anti-ram barriers.*



#### ACTIVATING DECISIVE ACTION:

## RAPID RESPONSE TO REAL-TIME CHALLENGES

The National Strategic Research Institute (NSRI) and the University of Nebraska System (NU) are known for their rapid response capabilities. By quickly expanding and delivering skills, research and resources, NSRI and NU support the U.S. Department of Defense (DOD) and U.S. Government in adapting to real-world events and managing evolving national security scenarios. In this period, NSRI and NU provided several deliverables to improve real-time action of responders and decision makers.

### Protecting Military Installations with One-of-a-Kind Facility

Since 2015, the Midwest Roadside Safety Facility (MwRSF) at the University of Nebraska–Lincoln (UNL) has supported ongoing projects with U.S. Transportation Command (USTRANSCOM) to develop a modified guardrail system that can protect military installations at home and abroad.

With funds awarded in this reporting period, the project reached nearly \$7 million in total awards. Led by NSRI Fellow Dr. Cody Stolle, UNL research assistant professor in engineering, the MwRSF is currently developing a new barrier that can absorb a 15,000-pound truck impacting at 50 miles per hour (mph) at a perpendicular angle. The unique, low-cost system can be installed to upgrade the security of

perimeter antipersonnel fences for robust resistance against a vehicle impact. Additional projects in progress will design and evaluate a swing gate for disrupting threat vehicles at speeds of 90 mph and draft enhanced guidelines for placement of traffic control devices that disrupt threat vehicles.

With a collective century of transportation experience, robust laboratory capabilities and access to NSRI and the UNL Holland Computing Center, the MwRSF provides a unique combination of capabilities the DOD can call upon.

MwRSF's ongoing deliverables to USTRANSCOM for roadside and anti-ram barriers are keeping the Nation's warfighters safe right now. They allow smooth access to military installations through entry control facilities and shield the Nation's critical infrastructure.

## Training Responders on New Tech to Prepare for Advanced Threats

With advancements in artificial intelligence and unmanned aerial vehicles, U.S. National Guard Civil Support Teams (CSTs), which are the Nation's experts for countering weapons of mass destruction (CWMD), and others, must closely monitor and prepare for new threats.

In the summer of 2023, NSRI quickly evolved its applied biosurveillance sampling and analysis expedition course to provide hands-on field training with one of the newest tools available for disaster responders: the MinION genomic sequencer.

The full-spectrum operations biosurveillance experience constituted one of the first practical applications of the MinION device in an operational field environment to expand sample collection and analysis capabilities.

NSRI helped responders identify how to implement the MinION into their programming. The course also demonstrates a broader evolution for the NSRI field operations and training team — not only keeping pace with but setting the stage for putting new and emerging technologies in the hands of end users such as the CSTs.



NSRI training course participant uses his operational laboratory to prepare the complex samples collected for sequencing with the MinION.

## Modernizing Sequencing Capabilities for Expanded Use Against Biothreats

To support the forward-leaning DOD program strategy for biosurveillance documented in the 2023 Biodefense Posture Review, NSRI deepened its capabilities and expanded its capacity for sample exploitation and advanced sequencing to help DOD program managers create actionable, decision-focused information.

NSRI added new scientific staff, bringing to bear 25 years of combined experience, including 12 years of work in BSL-3 laboratories with Tier 1 Select Agents. The institute also enhanced its sequencing capabilities, Illumina MiSeq, iSeq and MinION instrumentation in an ISO 17025 environment at the NSRI Space Coast Field Office and Laboratory, which expanded its footprint by 1,200 square feet in summer 2024.

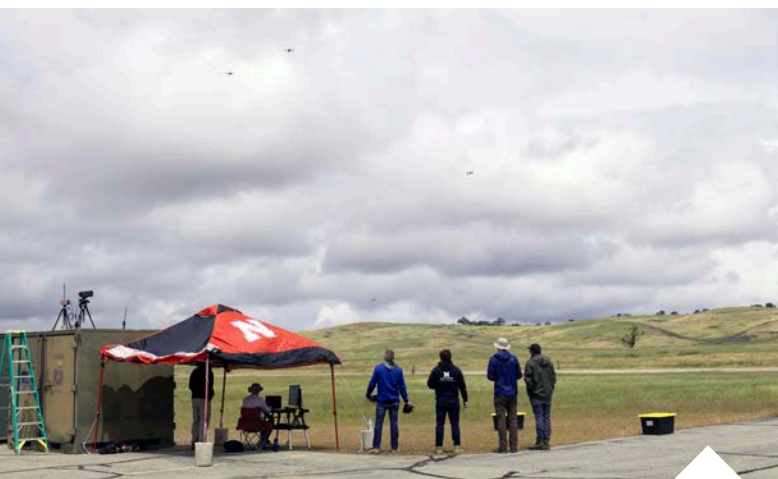
NU also offers capacity through resources such as the Bioinformatics and Systems Biology Core at the University of Nebraska Medical Center (UNMC). Led by NSRI Fellow Dr. Babu Guda, UNMC chief bioinformatics and research computing officer, the core develops methods and software tools for understanding biomolecular data illuminating scientific components such as protein structure, amino acids, DNA and RNA.

Rapid, confident decision-making based on reliable data can make a difference in threat mitigation. These projects apply a heightened level of foresight and anticipation of response needs. NSRI's proactive investment in advanced sequencing capabilities activates a new level of responsiveness for DOD partners.

## Expediting ISTAR Mission with Drone Enhancements

To help improve the U.S. military's ability to leverage multiple drones for intelligence, surveillance, target acquisition and reconnaissance (ISTAR) missions, the U.S. Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory called upon the expertise and experience of the Nebraska Intelligent MoBILE Unmanned Systems (NIMBUS) Lab at UNL. The lab is known for bringing drones closer to each other and the world. Notable projects have enabled drones to collect water, soil and air samples; enabled long-duration aerial





*UNL NIMBUS Lab team demonstrating a 10-drone ISTAR swarm at the Joint Interagency Field Experiment in Camp Roberts, California, May 2023.*

sampling and ground-emplaced sensing; and leveraged the ability of a Group 2 unmanned aerial system (UAS) to deliver Group 1 systems further than they could reach on their own.

NSRI Fellows from NIMBUS, along with NSRI Fellow Dr. Ben Riggan of UNL electrical and computer engineering, developed an integrated system for delivering, controlling and monitoring a swarm of drones in an outdoor, austere environment without relying on Wi-Fi or other external networks, while leveraging commercial off-the-shelf components to lower acquisition costs.

The team of UNL researchers and students successfully demonstrated a 10-drone ISTAR swarm at the Joint Interagency Field Experiment in Camp Roberts, California. This research is one step forward toward enabling field testing of swarm algorithms, low-cost swarm platforms and systems that can work in communication-denied environments.

## Increasing Speed for Operations Access to USSTRATCOM Archives

U.S. Strategic Command's (USSTRATCOM) archive is the Nation's nuclear history repository of original documents, photographs and films. It is accessed often by Joint Staff, Services, Combatant Commands, Components and military schoolhouses to support training and strategy.

In 2023, NSRI received a USSTRATCOM contract to make physical archive records electronically

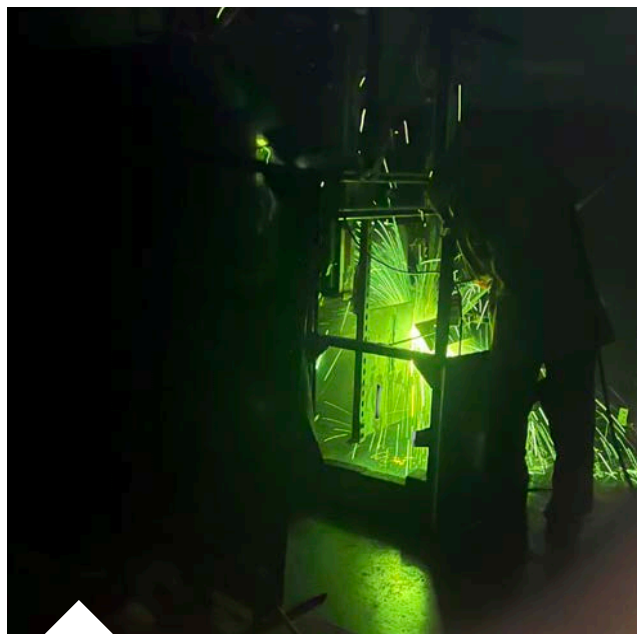
accessible and searchable — a vital step in activating the usefulness of the archive. Over three years, NSRI staff will index, digitize and add metadata to the records.

The USSTRATCOM archive provides critical daily decision-making support for military leaders who need to understand the why and how of past military events to successfully support impending missions. The project makes the information more accessible and actionable.

## Enhancing Thermal Lance Capabilities to Improve Missions

In the field, every second and every pound counts. Continuing its long-time CWMD efforts with the Defense Threat Reduction Agency, NSRI scientists and engineers evaluated thermal lance technology, a key piece of the breaching tool kit used to rapidly cut through barriers. Exploring chemistries and mechanical designs, the team down-selected and modified thermal lance properties to increase cutting performance for end users. The NSRI team ensured the lance could function with an existing oxygen-generation system.

Now in the hands of active breaching teams, the lance is an essential asset commanders and their units can employ to complete missions more effectively and efficiently.



*NSRI researchers evaluate improved thermal oxygen lances to rapidly breach steel barriers.*



A U.S. National Guard 43rd Civil Support Team member scales ship during an NSRI-designed mobility and delivery training evolution, Federal Law Enforcement Training Center, Charleston, South Carolina, August 2022. Several local partners including the U.S. Coast Guard participated in the exercise.

#### SUPPORTING COMMAND STRATEGY:

## OPTIMIZED DATA & SKILLS FOR EFFICIENT DECISION MAKING

During this reporting period, researchers from the National Strategic Research Institute (NSRI) and the University of Nebraska System (NU) leveraged data and training expertise to create and elevate tools, systems and experiences for leaders and end users in the U.S. Department of Defense (DOD) and U.S. Government. The goal is to simulate critical, real-time decisions — and then support data-backed, skill-based decisions with confidence in the field.

### Immersive Courses Sharpen Responders' Skills For Future Events

Confined spaces on a cargo ship complicate a responder's ability to remove contraband safely. In August 2022, NSRI held a mobility and delivery training evolution for the U.S. National Guard 43rd Civil Support Team (CST) and mission partners at the Federal Law Enforcement Training Center, Charleston, South Carolina. Participants collaborated on standard operating procedures in a scenario designed to prepare them for ready response to real-world deployments.

In a 2023 NSRI experiential course in Los Angeles, California, law enforcement personnel and first responders improved their ability to quickly identify illicit biological weapons. Participants designed, built and produced biological stimulants. All participants ranked every portion of the unique course as excellent — 5 out of 5 points.

Then, throughout 2023, in partnership with the U.S. Drug Enforcement Agency and the New York Police Department Counterterrorism Unit, NSRI trained 134 operators and partners attached to four CSTs for advanced response to chemical, biological and explosive threats. Exercises and courses were held in the field and at the NSRI National Capital Region Laboratory & Conference Center in Annapolis Junction, Maryland. Events focused on chemical pharmaceutical-based agents, homemade explosives, narcotics, chemical rocket motors and chemical signature recognition.

Since 2016, responders from 150 federal agencies have completed 6,000 NSRI experiences. These experiences bolster responder defense against evolving threats through scenarios that authentically reproduce future threats and challenges they are likely to face on the ground.

## Digital Toolkit Provides Real-Time Monitoring, Analysis for Soldier Readiness

A U.S. Army Combat Capabilities Development Command Soldier Center (DEVCOM SC) program aims to measure, predict and enhance soldier and squad close-combat performance. Since late 2020, NSRI Fellow Dr. Aaron Likens, assistant professor at the Center for Research in Human Movement Variability at the University of Nebraska at Omaha (UNO), has worked to contribute a “Soldier Readiness Toolkit” to the DEVCOM SC effort.

The toolkit’s software collects and analyzes data generated by small wearable sensors placed on a

soldier’s body and turns that information into critical insights into the soldier’s movement patterns. Dr. Likens’ team developed the software utilizing data collected from the Biomechanics and Engineering Team at DEVCOM SC in Natick, Massachusetts. The data was gathered through several multi-day studies during which soldiers participated in a 72-hour mission and recovery scenario that measured their movements, cardiovascular activity, baseline and recovery strength and biomarkers.

The UNO team successfully analyzed the test data, calibrated the tool and delivered the toolkit as planned to DEVCOM SC. The team has presented at several academic and industry conferences and September 2024 published “Altered movement dynamics in soldiers undergoing multiple bouts of load carriage” in Applied Ergonomics.

## Reducing USSTRATCOM Operational Risk with Improved Tools

In summer 2023, NSRI supported a programmatic milestone for U.S. Strategic Command’s (USSTRATCOM) Mission Planning and Analysis System (MPAS), conducting a successful initial operational test and evaluation of integrated nuclear-weapons-effects tools and capabilities developed by the Defense Threat Reduction Agency with MPAS applications. These tools allow USSTRATCOM to use nuclear weapons effects information in new and more in-depth ways during planning and operations. The enhancement is critical for understanding the impacts of nuclear weapon use in a new era.

In late 2023, the Air Force Life Cycle Management Center (AFLCMC) awarded NSRI \$4 million to continue its support, which the institute has provided since 2017.

The sophisticated integrations produced by the NSRI-led team streamline essential workflows and allow USSTRATCOM leaders to ask increasingly complex questions surrounding both intended and unintended weapons deployment. Ultimately, this work supports clearer, more efficacious decisions by U.S. defense leaders and operational planners.



Researchers from the University of Nebraska at Omaha Department of Biomechanics adjust sensors to prepare for demonstration on the Computer Assisted Rehabilitation Environment (CAREN) system, one of several advanced technologies that enable UNO researchers to study the motion and operation of the human body.



## NCITE, NSRI Deliver Report on Combating Terrorist Use of Explosives

The National Counterterrorism Innovation, Technology, and Education Center (NCITE), a U.S. Department of Homeland Security (DHS) Center of Excellence based at the University of Nebraska at Omaha, published the report, *Research Challenges in Combating Terrorist Use of Explosives in the United States*, based on research conducted during the reporting period and funded by DHS.

The report summarizes the current terrorist improvised explosive device (IED) threat environment and identifies 10 key priorities for explosives experts — in government, industry and academia — for preventing and disrupting future attacks. The NSRI field operations and training team contributed operational support and subject matter expertise to the project.

The insights and recommendations provided in the report enable better decision-making at all levels, from strategic planning to tactical operations.

## Researching Electromagnetic Environment Instrumentation & Data Collection

The electromagnetic spectrum (EMS) is nonphysical but transcends all physical domains, both military and civilian. There is a significant push to reestablish U.S. EMS dominance in this operational area. In 2023, under Unified Command Plan 22, the DOD-designated USSTRATCOM as its EMS Enterprise operational lead. As USSTRATCOM's DOD-designated UARC, NSRI immediately shifted to contribute significantly to this priority.

USSTRATCOM's Joint Center for Electromagnetic Readiness (JCER) at Nellis Air Force Base, Nevada, awarded NSRI \$871,526 to use its evaluation and modeling expertise to help JCER communicate actionable data to the services. Initial tasks evaluated instrumentation and data capture capabilities and characterized the electromagnetic environment. NSRI hired an analyst to collaborate with NU researchers.

NSRI and NU are contributing risk analysis, research, operational environment characterization and deterrence analysis leveraging many NU campus resources. The stage is being set for research focusing on the evaluation of emerging technologies and their integration into future evaluation architecture.

## NATO Leverages NU Multi-Actor Deterrence Analysis Modeling

Since 2019, NSRI Fellow Dr. Michelle Black, UNO associate professor of political science, has leveraged NSRI resources to execute development of a multi-actor deterrence analysis model (MADAM) for the North Atlantic Treaty Organization (NATO). The model has matured into the establishment of the Nebraska Deterrence Lab at UNO led by Dr. Black.

In this reporting period, Dr. Black and NSRI Fellow Dr. Deanna House, tested MADAM within the development of a series of NATO wargames on space deterrence. The two are part of a 37-person research team formed by NATO to develop and test a comprehensive space deterrence framework. Such a framework would employ a full spectrum of deterrence options and both national and NATO instruments of power.

The NATO team will analyze wargame results and distribute an executive-level report, and the NATO Science and Technology Board chartered the team to continue through March 2026. This is just one example of many ongoing applications and deliverables of the Nebraska Deterrence Lab and MADAM framework that are available to help U.S. commanders and Allies deter and respond to nefarious acts.



The Multi-Domain Space Deterrence Framework 2024 wargame brought together 37 participants from nine NATO nations, including NSRI Fellows Dr. Michelle Black and Dr. Deanna House. A majority of participants are pictured here outside the Majoor Jan Linzel Complex in The Hague in the Netherlands, May 2024.

# DEDICATED LEADERSHIP, COMMITTED COLLABORATORS

The National Strategic Research Institute's (NSRI) achievements toward its mission would not be possible without the guidance of its distinguished Board of Directors, leadership from the University of Nebraska System's (NU) campuses, commitment from its staff, collaboration with researchers and students and unwavering support of its key stakeholders — leaders from across the U.S. Department of Defense (DOD), U.S. Strategic Command (USSTRATCOM), U.S. government (USG), research universities and partners. The following pages feature current leaders and many of the individuals who have contributed significantly to NSRI's mission throughout the reporting period. Their investments of time and talent and their subject matter expertise shaped NSRI's research agenda and ensured solutions were delivered into the hands of defense community end users.

▶▶▶ Meet the full NSRI leadership team and research staff at [nsri.nebraska.edu/experts](https://nsri.nebraska.edu/experts).

AS OF NOVEMBER 1, 2024

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*Science & Technology Advisor*

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**John Tencer, MBA**  
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*Associate Executive Director  
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Destruction Allied Programs*

**Christopher Yeaw, Ph.D.**  
*Associate Executive Director  
Strategic Deterrence & Nuclear  
Programs*

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*President  
University of Nebraska System*

**Rodney D. Bennett, Ed.D.**  
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University of Nebraska at  
Kearney*

**H. Dele Davies, M.D.**  
*Interim Chancellor  
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**Joanne Li, Ph.D.**  
*Chancellor  
University of Nebraska at  
Omaha*

**Mike Boehm, Ph.D.**  
*Vice President, University of  
Nebraska System  
Vice Chancellor, Institute  
of Agriculture and Natural  
Resources, University  
of Nebraska–Lincoln*

## Principal Investigators July 1, 2022 - June 30, 2024

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Kenneth Bayles, Ph.D., UNMC

Misty Bensman, MS, NSRI

David Berkowitz, Ph.D., UNL

Michelle Black, Ph.D., UNO

Justin Bradley, Ph.D., UNL

Paul Brantmier, Ph.D., NSRI

Keely Buesing, M.D., UNMC

Wes Carter, NSRI

Bill Charlton, Ph.D., NSRI

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John Lowe, Ph.D., UNMC

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Daniel Polanski, NSRI

Patrick Rhoads, NSRI

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Michael Wiley, Ph.D., UNMC

Neal Woollen, DVM, Ph.D., MSS, NSRI

Christopher Yeaw, Ph.D.

## Faculty Project Contributors July 1, 2022 - June 30, 2024

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Benjamin Riggan, Ph.D., UNL

Anthony Sambol, M.A., UNMC

Kiran Sapkota, Ph.D., UNMC

Matthew Zimmerman, Ph.D., UNMC



**“The University of Nebraska–Lincoln is proud of its position as Nebraska’s Big Ten, flagship, land-grant, research institution, and with that status comes a responsibility to engage in teaching and research of the highest importance. Through NSRI, UNL researchers are helping to shape a future that keeps Americans as safe and secure as possible in a changing and increasingly dangerous world. UNL researchers are determined to lead the way in providing innovative solutions for the DOD to the country’s most pressing problems — now and in the future.”**

**RODNEY D. BENNETT**

*Chancellor, University of Nebraska–Lincoln*



# NSRI FELLOWS

The NSRI Fellows Program amplifies NU's support to the DOD by engaging leading researchers from the system's four campuses — University of Nebraska at Kearney, University of Nebraska–Lincoln, University of Nebraska Medical Center and University of Nebraska at Omaha. In total, 156 NU researchers serve as NSRI Fellows, deepening their understanding of DOD needs and ensuring NSRI has ready access to leading expertise and laboratories, as well as student capacity. In academic year 2023–2024, 22 fellows were involved in projects totaling \$31.4 million in awarded funding.

▶▶▶ Access details of the program and efforts at [nsri.nebraska.edu/fellows](https://nsri.nebraska.edu/fellows).



## NSRI Fellows Conference

The annual invite-only NSRI Fellows Conference took place in April 2023 and April 2024 at Nebraska Innovation Campus, Lincoln, Nebraska, convening hundreds of fellows, DOD and federal government leaders, NU administrators and NSRI staff for networking and learning.

*Left: Wade Mueller, senior technical advisor for the Joint Electromagnetic Spectrum Operations Center of USSTRATCOM, provides keynote address at the 2024 NSRI Fellows Conference. Right: NSRI Fellow Dr. Ben Riggan leads the AI/ML working group breakout session at the 2024 conference. Panelists included Martin Apprich, USSTRATCOM chief data scientist; Dr. MaryAnne Fields, Army Research Laboratory intelligent cyber-physical systems program manager; and NSRI Fellow Dr. Dustin White, UNO associate professor of economics.*



## NSRI Fellows Working Groups

In 2023, NSRI Fellows formed working groups to create technical, action-oriented conversations and interdisciplinary teams ready to tackle DOD challenges.

- ▶ Artificial Intelligence & Machine Learning
- ▶ Biological Defense
- ▶ Chemical Defense
- ▶ Food, Agriculture & Environment Security
- ▶ Joint Electromagnetic Spectrum Operations
- ▶ Medical Countermeasures
- ▶ Strategic Deterrence
- ▶ Wearable Sensors



**“The University of Nebraska and NSRI partnership is an excellent example of how collaboration on cutting-edge research drives innovation and solutions to address current and emerging national and global security challenges. It is exciting to see how this collaboration continues to generate timely outcomes that make our Nation and the globe safer for all.”**

**TALA AWADA, PH.D.**

*NSRI Fellow, Physiological Plant Ecologist & Agricultural Research Division Associate Dean, University of Nebraska–Lincoln*

### UNIVERSITY OF NEBRASKA AT KEARNEY

Paul Burger, Ed.D.  
Kim Carlson, Ph.D.  
Christopher Exstrom, Ph.D.  
Krista Forrest, Ph.D.  
Keith Geluso, Ph.D.  
Angela Hollman, Ph.D.  
Kristy Kounovsky-Shafer, Ph.D.  
Austin Nuxoll, Ph.D.  
Basheer Qolomany, Ph.D.  
Julie Shaffer, Ph.D.  
Melissa Wuellner, Ph.D.

### UNIVERSITY OF NEBRASKA—LINCOLN

Craig Allen, Ph.D.  
Matt Andrews, Ph.D.  
Tala Awada, Ph.D.  
Sina Balkir, Ph.D.  
Aron Barbey, Ph.D.  
Scott Barrett, Ph.D.  
Mark Bauer, Ph.D.  
Bill Belcher, Ph.D., RPA,  
D-ABFA  
David Berkowitz, Ph.D.  
Rick Bevins, Ph.D.  
Andreia Bianchini-Huebner, Ph.D.  
Nicole Buan, Ph.D.  
Ed Cahoon, Ph.D.  
Mehmet Can (John) Vuran, Ph.D.  
Byron Chaves-Elizondo, Ph.D.  
Clay Cressler, Ph.D.  
Carrick Detweiler, Ph.D.  
Brittany Duncan, Ph.D.  
Pat Dussault, Ph.D.  
Loren Gielser, Ph.D.  
Ingrid Haas, Ph.D.  
Andrew Harms, Ph.D.  
Tomáš Helikar, Ph.D.  
Michael Hempel, Ph.D.  
Matt Hille, Ph.D.  
Jerry Hudgins, Ph.D.  
Qing Hui, Ph.D.

Nathan Huynh, Ph.D.  
Scott Johnson, MS  
Srivatsan Kidambi, Ph.D.  
Rebecca Lai, Ph.D.  
Xu Li, Ph.D.  
Dustin Loy, Ph.D., DVM, DACVM  
Yongfeng Lu, Ph.D.  
Louise Lynch O'Brien, Ph.D.  
Eric Markvicka, Ph.D.  
Patrice McMahon, Ph.D.  
Scott McVey, Ph.D., DVM  
Rupal Mehta, Ph.D.  
Martha Morton, Ph.D.  
Benny Mote, Ph.D.  
Rod Moxley, Ph.D., DVM  
Carl Nelson, Ph.D.  
Jill O'Donnell, MA  
Angela Pannier, Ph.D.  
Massimiliano Pierobon, Ph.D.  
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Yi Qian, Ph.D.  
Byrav Ramamurthy, Ph.D.  
Ben Riggan, Ph.D.  
Mark Riley, Ph.D.  
John Ruberson, Ph.D.  
Mario Scalora, Ph.D.  
Daniel Schachtman, Ph.D.  
Hamid Sharif, Ph.D.  
Cody Stolle, Ph.D.  
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Ashley Votruba, Ph.D.  
Hiep Vu, Ph.D.  
Harkamal Walia, Ph.D.  
Brian Wardlow, Ph.D.  
Eric Weaver, Ph.D.  
Karrie Weber, Ph.D.  
Tyler White, Ph.D.  
Richard Wilson, Ph.D.  
You (Joe) Zhou, Ph.D.

Craig Zuhlke, Ph.D.

### UNIVERSITY OF NEBRASKA MEDICAL CENTER

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Ken Bayles, Ph.D.  
Beth Beam, Ph.D.  
Jesse Bell, Ph.D.  
Nathan Bills, Ph.D.  
David Brett-Major, M.D.  
Mara Broadhurst, M.D., Ph.D.,  
DTM&H  
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Sid Byraredddy, Ph.D.  
Eric Carnes, Ph.D.  
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Shaun Cross, Ph.D.  
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Jared Evans, Ph.D.  
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Eleanor Rogan, Ph.D.

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CBSP (ABSA), RO FSAP  
Lauren Sauer, MSc  
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Micah Schott, Ph.D.  
Paul Sorgen, Ph.D.  
James Talmadge, Ph.D.  
Dong Wang, Ph.D.  
Steven Yeh, M.D., FASRS  
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### UNIVERSITY OF NEBRASKA AT OMAHA

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Sam Hunter, Ph.D.  
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Brian Knarr, Ph.D.  
William Kramer, Ph.D.  
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Jeremy Harris Lipschultz, Ph.D.  
Sara Myers, Ph.D.  
Jody Neathery-Castro, Ph.D.  
Lana Obradovic, Ph.D.  
Roni Reiter-Palmon, Ph.D.  
Ryan Riskowski, Ph.D.  
Denis Svechkarev, Ph.D.  
Dustin White, Ph.D.  
Xinqiu (Joe) Yao, Ph.D.  
Xiaoqian (Tiffany) Zhang, Ph.D.

# STUDENTS OF NSRI

As a trusted agent of the federal government, NSRI supports national interests and strategies by providing the DOD and USG with evolutionary and revolutionary solutions to the dangerous and emerging threats of today and of the future. One of the most critical solutions is a knowledgeable, capable and committed workforce equipped to carry forward 21st-century national security missions. NSRI invests its time, talent and resources into developing students from the NU campuses and beyond to help launch their defense-related careers.

▶▶▶ Access details of NSRI programs and positions at [nsri.nebraska.edu/workforce](https://nsri.nebraska.edu/workforce).

## Strategic Deterrence Interns

In total, NSRI has welcomed 38 undergraduate and graduate students from the NU campuses and 20 ROTC cadets from universities across the country into its mission through a strategic deterrence internship program. At least 13 of NSRI's interns have gone on to careers supporting national security.

In this reporting period, 19 NU students and 12 ROTC students participated, delivering research and tools to USSTRATCOM for wargaming, database management and joint electromagnetic spectrum operations research. The ten-week experience culminates in a briefing to senior USSTRATCOM leaders at the command's headquarters, Offutt Air Force Base, Omaha, Nebraska.



Above: Lt. Gen. Thomas Bussiere (center), USSTRATCOM deputy commander, receives briefing from NSRI strategic deterrence interns at USSTRATCOM headquarters, Offutt Air Force Base, Omaha, Nebraska, August 2022.

Below: Brig. Gen. William Murphy (center left), USSTRATCOM mobilization assistant to the commander, with NSRI strategic deterrence interns following their briefing at USSTRATCOM headquarters, Offutt Air Force Base, Omaha, Nebraska, August 2023.





## Student Contributors

When working with NSRI and NU, DOD and USG agencies can provide incredible experiences for our Nation's emerging scholars. In this reporting period, 22 NU students brought forward fresh perspectives and innovative approaches to accelerate project outcomes. These opportunities fostered a dynamic environment of knowledge exchange among seasoned researchers and the next generation of security experts. Following are perspectives from three of the student contributors.



Brianna Parr is contributing to a project to create a powered air-purifying respirator. Funded by the U.S. Public Health Service corps of the U.S. Department of Health and Human Services and the University of Nebraska Collaboration Initiative the helmet will provide a much needed solution for keeping healthcare workers safe, especially those working in austere conditions, such as military medics.

**“This project has strengthened my sense of patriotism as I have learned what individuals in national defense have gone through, specifically during the COVID-19 pandemic.”**

### BRIANNA PARR

*Public Health, University of Nebraska Medical Center*



Weston Kelley contributed to development of a modified guardrail system for U.S. Transportation Command through a new \$800,000 contract award to the Midwest Roadside Safety Facility at the University of Nebraska–Lincoln.

**“We have to consider constraints and limit our assumptions when developing this system as this project will affect military personnel in the real world. I have been learning that balancing quality detailed engineering work while considering client financial and logistical limitations will pay dividends for this project.”**

### WESTON KELLY

*Mechanical and Materials Engineering, University of Nebraska–Lincoln*



After completing the 2022 NSRI strategic deterrence internship, Caden Puntney went on to contribute to USSTRATCOM through an internship that focused on data science.

**“At USSTRATCOM, I was able to further develop those communication skills by frequently participating in meetings. I also grew my technical skills in a variety of ways while there, one being my ability to present meaningful data in an easy-to-understand manner.”**

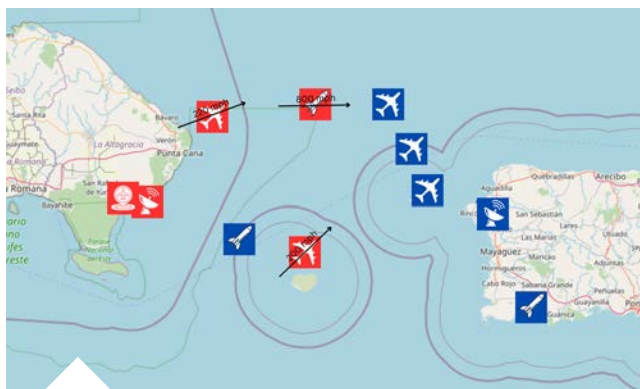
### CADEN PUNTNEY

*Computer Science, University of Nebraska–Lincoln*

# CULTIVATING INNOVATION

## NU-Funded Independent Research

Since 2021, the University of Nebraska System (NU) has invested in research and development projects to address the National Strategic Research Institute's (NSRI) mission and most-critical customer challenges. In this reporting period, eight projects were awarded through the University of Nebraska Collaboration Initiative (NUCI) and seven were completed. NU's ongoing investment in ideas from NU researchers demonstrates its dedication to not only meeting current needs but forging ahead with foresight. Following are summaries of two ongoing impacts from this investment.



### NUCLEAR DETERRENCE THEORY FOR A MULTI-POLAR WORLD

Deterrence remains the most important element of the U.S. nuclear strategy, but for the first time in history, the U.S. must deter two nuclear-armed peer adversaries — Russia and China. This project aimed to extend game theory and agent-based modeling to the new tripolar dynamic. Insights gained can help decision makers understand how individuals, groups and nations may interact when engaging with one another. Data generated from the project has been presented at two national economic meetings and will be featured in an upcoming journal publication.

*Pictured: Game theory examination of armed conflict considers the movement of warfighting assets.*



**“Innovation and collaboration are central to our mission at the University of Nebraska at Omaha. The faculty featured in this report exemplify the forward-thinking spirit that defines our university, Nebraska and NSRI. The problems they solve keep our Nation’s heroes on the cutting edge of research and development, ensuring we are safe to teach, work, learn and grow as citizens. We are immensely proud of their contributions.”**

**JOANNE LI, PH.D.**

*Chancellor, University of Nebraska at Omaha*



### SAFE, SELF-ADMINISTERED, RAPID-ACTING ANTI-INFECTIVE

This project advanced to development an agent that can be administered either prior to or following viral exposure to prevent illnesses such as COVID-19. This particular anti-infective therapy is distinct because it has the potential to be self-administered as a nasal spray. The project led to a follow-on NUCI project, and the team presented at the CWMD/MCDC: 2024 Winter Medical & WMD Countermeasure Symposium. The team is now working on a patent application and publication.

*Photo: Stock image.*

## Strategic NU Partnerships

To connect the DOD with the resources, capabilities and capacity it needs from NU, NSRI bonds with key partners across the four NU campuses, hosting events, launching strategic initiatives and amplifying one another's impacts. Following are some of NSRI's critical partners from this reporting period.

### NATIONAL COUNTERTERRORISM INNOVATION, TECHNOLOGY & EDUCATION CENTER (NCITE)

Housed at the University of Nebraska at Omaha, NCITE is a U.S. Department of Homeland Security Center of Excellence involving more than 50 experts from partner institutions across the U.S. and Europe. NCITE collaborators aim to innovate, educate and create new terrorism prevention strategies while building a workforce pipeline in the STEM and homeland security fields. NSRI contributed to an NCITE project this period, and several NCITE researchers serve as NSRI Fellows.

*Photo: NSRI Fellows and interns with organization leaders at the 2024 ENVISION Conference hosted by NCITE, Omaha, Nebraska.*



### GLOBAL CENTER FOR HEALTH SECURITY

The Global Center for Health Security at the University of Nebraska Medical Center (UNMC) is a culmination of 20 years of persistence, planning and training at UNMC to build emergency preparedness capacity. Several center researchers serve as NSRI Fellows, and NSRI partnered with the center and the UNMC office of research to exhibit at the 2023 Military Health System Research Symposium (pictured).



### INSTITUTE OF AGRICULTURE & NATURAL RESOURCES (IANR)

NSRI's food, agriculture and environment security (FAES) focus area would not be possible without the leadership and intellectual capacity of IANR at the University of Nebraska–Lincoln. IANR brings wide-ranging expertise from nearly every level of food and agriculture production as well as environmental disciplines. It is a worldwide leader in research related to precision agriculture and ag tech; integrated cropping and water; food processing; agricultural economics; beef production; and resilience of agricultural working landscapes, among many other disciplines.

*Photo: Dr. Mike Boehm, vice president and vice chancellor of agriculture and natural resources, provides a welcome at the March 2023 FAES launch workshop with 60 faculty in attendance.*





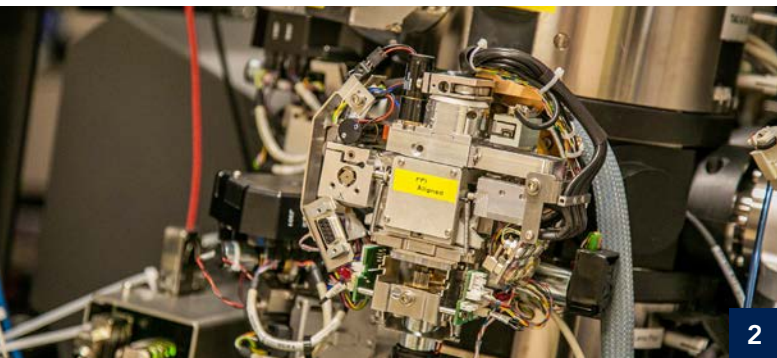
# EXPANDED FACILITIES & CAPABILITIES



NU's four campuses continue to invest in leading facilities to increase capabilities and capacity the DOD can leverage. Following are examples from the reporting period.

The Engineering Research Center (ERC) at the University of Nebraska–Lincoln (UNL) completed a two-phase, nearly \$200 million upgrade and expansion with 87,000 square feet of engineering laboratory and collaborative student work spaces, including labs focused on soft materials, biomedical engineering and light-matter interactions.

*Photo 1: UNL engineering student adjusts a modular high-vacuum laser processing system in NSRI Fellow Dr. Craig Zuhlke's lab located in the ERC.*



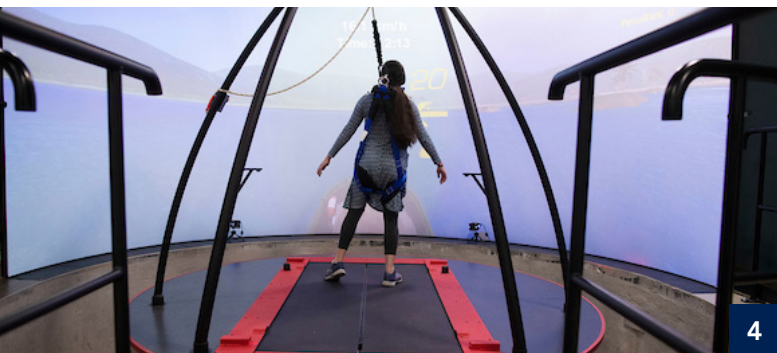
The CryoEM Core Facility at UNL now houses the state's first cryo-electron microscope, which enables researchers to observe biological molecules, complexes and cells at near-atomic resolution.

*Photo 2: Close-up of the high-throughput equipment, which includes a 200kV Glacios CryoEM Transmission Electron Microscope, a Falcon4i electron detector camera, aberration-free image shift and fringe-free imaging.*



In 2023, the Infectious Diseases Air Transport Training Facility at the University of Nebraska Medical Center was approved. In collaboration with internationally recognized experts, the up to \$20 million facility will include a large space to house a C-130, C-17 and Negatively Pressurized Conex (NPC) training units. The DOD provided initial funding.

*Photo 3: NPC unit being delivered to UNMC campus for installation.*



The 53,000-square-foot Biomechanics Research Building at the University of Nebraska at Omaha features a virtual reality laboratory, machining and prototyping core, tissue analysis core, advanced materials lab and more to engage in cutting-edge research that can help treat and prevent injuries and disorders that affect any patient's ability to mobilize.

*Photo 4: The Computer Assisted Rehabilitation Environment (CAREN) system.*

NSRI invests in facilities and laboratories conveniently located for federal government access. In this reporting period, several facilities expanded to accommodate DOD projects.

The NSRI National Capital Region Laboratory and Conference Center, which boasts leading collaboration technology and multiple meeting rooms, was expanded by 15,000 square feet to build out a chemical wet lab, analytical chemistry laboratory and a rapid prototyping engineering space. The facility also offers a 4,300-square-foot flex space, which is often used for scenario-based exercises, tabletop exercises, work group discussions, laboratory trainings and programs and technology reviews and demonstrations. The facility is conveniently located approximately five miles from Fort Meade, 20 miles from the Pentagon and 30 miles from the headquarters of the Defense Threat Reduction Agency (DTRA).

The NSRI Space Coast Field Office & Laboratory serves as a test bed and home of multiple DOD-sponsored projects for DTRA, the Defense Advanced Research Projects Agency, U.S. Special Operations Command and the Intelligence community. More than 220 sponsors, contractors and NU researchers visited the facility throughout the reporting period. Capabilities upgrades during this period included next-generation sequencing, mass spectrometry, 3-D printing and a dedicated classroom to support training and field operations.

▶▶▶ Explore an interactive list of NSRI and NU facilities, centers and cores at [nsri.nebraska.edu/facilities](https://nsri.nebraska.edu/facilities).

*NSRI Space Coast Field Office's new 1,200-square-foot laboratory space allows the team to provide next-generation sequencing, mass spectrometry and 3-D printing.*

## NSRI LOCATIONS

- ▶ Headquarters  
Scott Technology Center, Omaha, NE
- ▶ Research Office at U.S. Strategic Command  
Offutt Air Force Base, Omaha, NE
- ▶ National Capital Region (NCR) Laboratory & Conference Center  
Annapolis Junction, MD
- ▶ Space Coast Field Office & Laboratory  
Melbourne, FL
- ▶ Fredericksburg Field Office & Laboratory  
Fredericksburg, VA
- ▶ Collaborative Biosecurity Laboratory  
Institute of Agriculture and Natural Resources  
University of Nebraska–Lincoln, Lincoln, NE
- ▶ Engagement Hub  
Nebraska Innovation Campus, Lincoln, NE



# CONTRACTING & BUSINESS PROCESS

As a University Affiliated Research Center (UARC) designated by the U.S. Department of Defense, the National Strategic Research Institute (NSRI) at the University of Nebraska accesses an indefinite delivery, indefinite quantity (IDIQ) contract vehicle through U.S. Strategic Command (USSTRATCOM), which shortens the timeline from identification of need to contract award and creates trusted, collaborative relationships.

Benefits of doing business with NSRI include:

- ▶ Comprehensive knowledge of sponsors' requirements and problems
- ▶ Broad access to defense-applicable information, including proprietary data
- ▶ Vast corporate knowledge
- ▶ Independence and objectivity
- ▶ Quick-response capability
- ▶ Current operational experience
- ▶ Freedom from real or perceived conflicts of interest

## ADDITIONAL OPTIONS

NSRI also receives funding via:

- ▶ Other IDIQ contracts
- ▶ Direct contracting vehicles
- ▶ Other transaction (OT) agreements
- ▶ Cooperative agreements, grants
- ▶ Standard Form (SF) 182
- ▶ Government purchase card (GPC)

## IDIQ Acquisition Process

NSRI's integrated team process (ITP) significantly reduces the contracting timeline and increases responsiveness to requirements. Four contract-implementing stakeholders play roles in the following contracting process — the customer, USSTRATCOM J834 (J834), 55th Contracting Squadron (55 CONS) and NSRI.

### REQUIREMENTS IDENTIFICATION

- ▶ Customer identifies requirement
- ▶ Customer conducts fact finding with NSRI
- ▶ Customer contacts J834

### REQUIREMENTS DEVELOPMENT

- ▶ J834 provides templates and assists with package development
- ▶ Customer submits package to J834
- ▶ J834 submits package to 55 CONS

### INTEGRATED TEAM PROCESS (ITP)


- ▶ 55 CONS initiates ITP
- ▶ All stakeholders collaborate during ITP
- ▶ 55 CONS closes ITP

### ACQUISITION PROCESS

- ▶ 55 CONS issues Request for Proposal
- ▶ NSRI submits proposal
- ▶ Customer conducts technical evaluation
- ▶ 55 CONS obtains contract clearance

### CONTRACT AWARD





***JOIN US AS WE WORK  
WITH OUR PROTECTORS TO  
PROACTIVELY DETER, RAPIDLY  
RESPOND TO AND SAFELY  
MITIGATE THE EVER-CHANGING  
THREATS TO OUR NATION.***

**RICK EVANS**

Maj. Gen., USAF (Ret.)  
NSRI Executive Director



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