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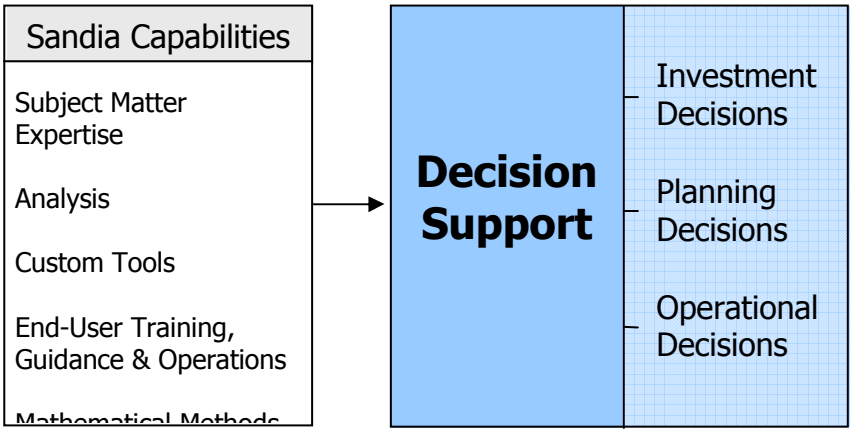
Chem/Bio Emerging Threat Capabilities

The threat of state-sponsored or terrorist attacks with chemical, biological, radiological, and nuclear (CBRN) materials presents grave danger to the warfighter in both forward deployed and CONUS/OCONUS military installations. Emerging threats, in particular, present unique challenges to defense due to their unknown nature. We recognize the challenges associated with two types of emerging threats, in particular: naturally occurring pandemics and modified agents. Critical decisions must be made surrounding these threats—how to characterize the threat and then detect, respond, and recover in the case of an event.

Sandia National Laboratories is a proven leader in providing decision support in the context of national threats—support for investment decisions, planning decisions, and operational decisions. Sandia often provides decision support for poorly defined, uncertain problems, refining the problem and the questions addressed to provide meaningful and useful recommendations. The ill-defined nature of emerging threats makes them well-aligned to the analysis capabilities of Sandia. Using computer simulations and by developing new tools, Sandia can explore emerging problems and support decision makers. In addition, Sandia has experience in creating and evaluating concepts, such as technology requirements, to address problems posed by current and emerging threats. Sandia methodologies and tools are designed to be flexible, allowing for expansion as additional threats of interest emerge. By leveraging past experience and existing efforts, Sandia can readily address new threats and problem spaces.



Sandia provides decision support using a wide range of capabilities, including subject matter expertise, analysis, custom tools, end-user training, guidance, and operations, and mathematical methods.

Subject Matter Expertise

Sandia has a highly-trained, multi-disciplinary staff, ranging from scientists to systems analysts. Some examples of Sandia expertise include: agent properties for traditional and non-traditional agents, dissemination methods, infectivity and disease progression for biological agents, toxicity and warning properties of chemical agents, prophylaxis efficacy, decontamination, restoration, decision frameworks, and modeling. In addition, Sandia has broad connections to external research scientists, first responders, local government officials, and Federal agency representatives. Through this large network of expertise, Sandia is able to effectively understand, analyze, and make recommendations on a wide range of threat scenarios.

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Analysis

Sandia has a strong systems analysis reputation, devoting energy in recent years to analyses of terrorist attacks. Sandia has developed robust methodologies to analyze effectiveness of attacks, countermeasures, and responses. These methodologies can be used to analyze a range of threat agents and can accommodate new threats as they emerge. Sandia analysis supports decision makers—defining the information needed, an appropriate timeline for that information, and the tools and technologies needed to support the decisions.

Chemical Attacks

Sandia has developed a methodology for systematically identifying and evaluating chemicals that could be effective casualty agents if used specifically as airborne hazards in indoor terrorist attacks in large, high-value, civilian facilities. Using an advanced facility modeling tool, Sandia can perform simulations of plausible terrorist indoor chemical attacks and, using toxicity data of the chemicals of interest, determine how effective they would be in causing adverse health effects in chemical attacks. Sandia has completed a survey of 113 potentially toxic chemicals and has conducted a similar analysis of pesticides and drugs. Using this methodology, Sandia has the capability to evaluate additional agents of interest.

Sandia is currently studying, from a systems perspective, possible consequences of, and certain responses to, an attack involving a low-volatility chemical agent, including non-traditional agents (NTAs). By examining the casualty and physical contamination outcomes of selected plausible terrorist attack scenarios, the magnitude and consequences of such attacks can be placed into perspective, and certain requirements levied on emergency preparedness and response activities are defined. Sandia's work addresses agent dissemination, target restoration and reuse, especially decontamination methods, agent detection, and personal protection equipment (PPE.)

Biological Attacks

Sandia has the capability and methodologies in place to analyze a wide range of biological agents, incubation periods, and impacts on response timelines. In addition, Sandia modeling and analysis is compatible with a wide range of assumptions about agents (including modification of agents) to study the impact of these assumptions on attacks and on the effectiveness of responses to those agents.

Sandia has performed an analysis of multi-drug resistant anthrax (intentionally modified.) Sandia has addressed the feasibility of such an agent, the impact an attack by such an agent would have on current responses, and has provided recommendations for modifying response plans. As a tool in this analysis, Sandia led a workshop to discuss the issues with a broad range of experts from its network, including microbiologists, federal and state responders, and federal agency representatives. Sandia also developed a model of the impact of antibiotic resistance on response timelines.

Sandia has also worked on the DHS Reference Scenario with avian influenza as an exemplar of a modified existing agent. Through discussions with virologists from its network of experts and analyses performed, Sandia has a scientific and technological understanding of the possibility of modifying natural organisms.

Critical Infrastructure

Sandia is a prime contractor, with Los Alamos National Laboratory, for the National Infrastructure Simulation and Analysis Center (NISAC), a modeling, simulation, and analysis program that prepares and shares analyses of critical infrastructure and key resources including their interdependencies, vulnerabilities, consequences of disruption, and other complexities. NISAC provides analyses of the technical, economic, and national security implications of the loss or disruption of critical infrastructure/key resources, and assists in the understanding of infrastructure protection, mitigation, response, and recovery options. NISAC uses modeling and analysis tools to provide a broad set of infrastructure disruption analyses with rapid turn-around times. NISAC has analyzed the impact of a wide range of threats, including avian influenza and hurricanes.

Restoration

Sandia is a co-lead performer, with LLNL, in the Interagency Biological Restoration Demonstration (IBRD), a DHS-DOD collaborative program to develop, validate, and demonstrate multiple approaches for restoration actions following a biological attack that contaminates a wide urban area. A key aspect of this program is to examine civilian-military interactions and interdependencies in wide-area restoration. Sandia is performing systems analysis, developing a consequence management plan, developing wide area restoration technology capabilities, and conducting technology demonstrations. Sandia analysis is determining the "as-is" state of science, technology, policy and plans for restoring a

wide area, identifying the most important capability gaps to inform program investment priorities. The results of the analysis will feed into the consequence management plan and technology requirements. The methodologies used are flexible to accommodate additional threats, ranging from emerging CBRN attacks to natural disasters.

Custom Tools

Sandia has created a number of custom tools that provide capabilities to support some of the many decisions surrounding terrorist threats.

Sandia's Facilities Weapons of Mass Destruction Decision Analysis Center (FacDAC) is a capability developed to support an end-to-end approach to protection of critical facilities from terrorist attack. FacDAC combines multiple modules including HVAC and airflow models, population movement and behavior models, response options, disease models, etc., to capture the complexities involved in facility protection. FacDAC is used for analysis across a wide range of facilities protection issues, beginning with threat assessment and continuing with attack prevention / hardening, countermeasures evaluation, situational awareness requirements and detector siting, including signal interpretation and decision support. FacDAC is used to support the development of DHS/HHS Population Threat Assessments, and is also used to support the deployment of indoor biodetection architectures nationwide.

Sandia has created the Weapons of Mass Destruction Decision Analysis Center (WMDDAC) system-of-systems simulation tool as part of an effort to improve the ability of a major urban area in the United States to manage the consequences of a terrorist attack on its population and critical infrastructure. The WMDDAC system provides analyses to develop and evaluate system-level performance of alternative architectures and concepts of operation (ConOps) and provides a platform in which tradeoff studies can be performed. This tool also supports tabletop exercises and individual workshops in which stakeholders explore system ConOps. The architecture is flexible, allowing for expansion of the tool to include a variety of agents, parameter values, and assumptions.

To improve procurement and deployment decisions and inform existing and future technology investment, Sandia, with the University of New Mexico, is developing a CBRN Investment Planning and Analysis Tool (IPAT) that provides transparent, quantified cost/benefit estimates for CBRN attack prevention, detection, and response options. This tool leverages state-of-the-art modeling, simulation, and decision support tools by interfacing the Multivariate Decision Support Tool (MvDST) from the DTRA University Partnership Gold Team with the Weapons of Mass Destruction Decision Analysis Center (WMDDAC) simulation environment from Sandia National Laboratories. This tool provides planners a quantitative, justifiable basis for making CBRN architecture procurement decisions and informs S&T investment strategies. By utilizing WMDDAC, this tool has WMDDAC's flexibility to accommodate a wide variety of agents and decision parameters.

End-User Training, Guidance & Operations

Sandia has established relationships with a number of local jurisdictions and works with first responders and state and local officials to generate and/or modify response plans, ensuring their robustness for a large range of threats, including existing and emerging threats. From these relationships, Sandia has developed an understanding of issues involved in first response and how to create response plans that accommodate known and unknown threats.

Sandia, with LLNL, is leading the Training, Exercise and Lessons Learned (TELL) project, a national technology-driven system aimed at the national goal of creating proficiency to effectively manage catastrophic incidents. Sandia and LLNL have been developing and testing an overarching concept and architecture for the TELL system. Using computer simulation and other technology, TELL immerses emergency managers at all levels in a catastrophic incident, allowing

them to play through their actual contingency plans and evaluate their compliance with the National Incident Management System (NIMS). When mature, TELL will combine performance metrics from exercises across the country to provide a national gauge of readiness. The system will record and propagate lessons learned for readiness improvement. The TELL system is modular, scalable from a single incident to a large multi-jurisdictional nationwide exercise and designed for distributed remote access. Sandia and LLNL have developed a prototype TELL system and have been using this to conduct field experiments with responders to analyze TELL system concepts.

Sandia is leading a multi-laboratory effort to develop the Biological Warning and Incident Characterization (BWIC) system, an integrated decision support system for local jurisdictions that facilitates timely warning, attack assessment, communications, and effective response in the event of a biological attack. It provides a common interface to view an evolving event, support decision making, and support coordination activities such as planning, preparation, exercises, and training. Embedded within BWIC are agent reference tools, plume models, population models, and epidemiological forecasting models. Though initially developed for a specific list of biological agents, the platform has the capability to accommodate any number of agents and can be readily expanded to include emerging biological or chemical agents.

The Department of Homeland Security has established the BioWatch Indoor Reachback Center (BIRC) at Sandia National Laboratories to provide 24/7 scientific modeling support to decision-makers responding to a BioWatch Actionable Result (BAR) or similar biological incident at an indoor facility. The BIRC performs near real time event reconstruction to guide initial response efforts by providing information to help locate the source and extent of contamination. The BIRC incorporates the sampling results visualization and analysis portion of the Building Restoration Operations Optimization Model (BROOM) software toolset to enable a seamless transition from a response phase to restoration and recovery. The BIRC is also used to support planning, exercises and training for local jurisdictions. These techniques can be expanded to include additional agents beyond the current BioWatch agents.

Mathematical Methods

Sandia has established a strong presence in the realm of computational methods. Using mathematical models, Sandia has developed techniques in optimization under uncertainty, risk analysis, and operations research to provide a stronger mathematical basis for threat analyses and tools.

Sandia has developed an environment, known as Jess, that allows users to build software that has the capacity to "reason" using knowledge supplied in the form of declarative rules. More specifically, Jess is a tool for building expert systems, which are sets of rules that can be applied repeatedly to observations about the world. It makes use of advanced algorithms to determine in the most efficient manner which rules to execute in response to a given observation. Rule-based tools, like Jess, are particularly useful when one is developing algorithms or simulations in which there is a significant decision-making component where 1) the decisions can be captured in a set of rules, 2) the decisions are complex, and 3) the decisions are likely to change over time. Thus, Jess is applicable for such activities as encoding concepts of operation for responding to chemical and biological attacks or accidents.

Sandia is developing methods to effectively characterize opponent strategies and synthesize counter-strategies for complex asymmetric threat-based scenarios. Non-traditional approaches are used to infer these successful strategies from a large population of user data derived either from actual real-world events or from simulated (i.e., “gamed") scenarios. Strategies extracted from such simulations can be used to more optimally allocate limited protection resources and to accelerate a debate about the potentially expanded role of protection technologies. Further, the capabilities developed under this project are applicable to corresponding homeland security interests, such as the protection of chemical and biological agents and the development of improved response operations.

Sandia has invested significant resources in the development of DAKOTA, a framework for design optimization, parameter estimation, uncertainty quantification, and sensitivity analysis. This software implements a wide range of state-of-the art mathematical algorithms for these classes of analyses and has been designed specifically to work in conjunction with simulation codes. This opens up the opportunity to conduct extensive studies to evaluate, for example, the optimal design of a defensive architecture that is robust to uncertainties in attack characteristics and resource availability. This concept can be extended to any number of questions associated with homeland security and defense.

Sandia also has additional experience and capabilities in the radiological and nuclear areas. For more information on radiological/nuclear capabilities, contact Larry Brandt, lbrandt@sandia.gov.

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